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SURVEY OF THE BOUNDARIES OF THE YAVA-SUPAI INDIAN RESERVATION, ARIZONA.

By J. B. Girand.*

The accompanying photograph and map will give the reader an idea of the unique position this reservation occupies, as well as the difficulty attending the determination of its boundaries.

Situated in Cataract Canyon, a tributary of the Grand Canyon of the Colorado River, in northern Arizona, it is reached by two difficult and tortuous trails after making a descent of more than 4,600 ft. Here dwells a renegade band of Apache Indians, numbering in all about 185 souls, who call themselves Supais, Hava-Supais or Yava-Supais, which means Cascade or much flowing water. Under executive order dated March, 1882, there was allotted to this tribe

all that bottom land lying within the perpendicular walls of red sandstone bounding Cataract Creek, beginning at the crest of the third falls (this falls known as Bridal Veil) for the northern boundary and extending some four miles in a southeasterly direction to a narrow pass.

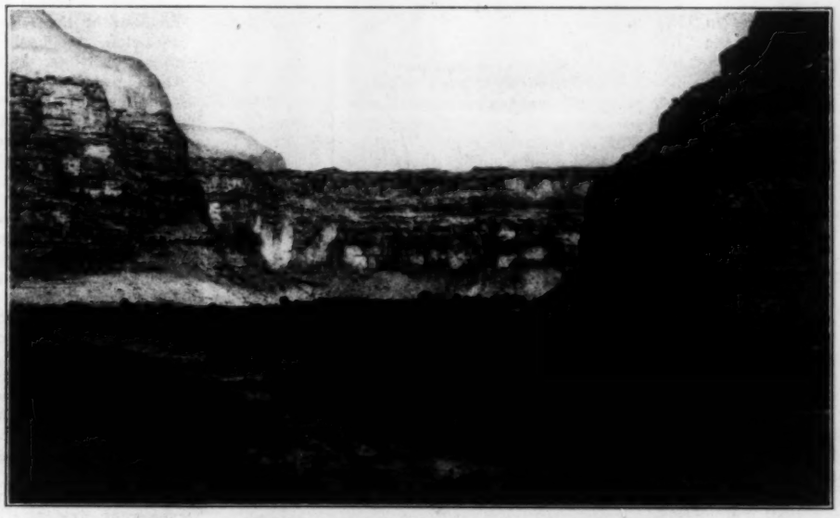
In 1881 Lieut. Carl Palfry, Corps of Engineers, U. S. A., made a reconnaissance survey of this reservation, and it was upon his survey that the executive order was based.

In order to comply with the special instructions of the Commissioner of the General Land Office, in making this survey, it was necessary after determinating the locus of the north and the south boundaries to meander the canyon along the perpendicular wall of red sandstone on either side, so as to include all of the bottom lands. At one place the canyon is about 300 ft. wide and the wall is about 500 ft. high.

Fallen boulders, tangle vines, an undergrowth of catclaw, chaparral and cacti of many varieties made this a more difficult task than would appear at first glance, and as in many places the sun never penetrates the recesses of this wall, in order to proceed with the work, settings had to be made wherever a sunny spot was convenient and the course of the line recovered. Considering the character of the country and the many difficulties with which the work was carried on it was extremely gratifying to note the closings as shown in the accompanying traverse sheet, as not a single course was corrected or changed from the original as taken in the field. (The table shows that there were 148 stations on the boundary line; that the total length of the line was 794.41 chains; that the northing totaled 27,759.37 links against 27,758.89 for the southings, or an error of 0.48 links; and that the eastings totaled 23,162.42 links against 23,158.35 for the westings, or an error of 4.07 links. The area of the reservation was 518.06 acres.—Ed.)

The survey was executed with an A. Lietz compound mining and solar transit, mountain type, with Saegmuller attachment. A steel tape was used in measuring all distances and plumb-bobs were in constant use.

*Prescott, Ariz.



GENERAL VIEW, YAVA-SUPAI INDIAN RESERVATION, ARIZONA.

THE PRESIDENTS OF FOUR NATIONAL ENGINEERING SOCIETIES.

(With inset sheet of portraits.)

In accordance with our annual custom, we present in this issue the portraits of the presidents of four great national engineering societies. The American Institute of Mining Engineers usually has a place on this sheet, but its president, Mr. James Gayley, is serving a second term, having been re-elected last summer. As we printed Mr. Gayley's portrait and biography a year ago, we give the fourth place on our sheet to the President-elect of the Canadian Society of Civil Engineers, Mr. Hugh Lumsden, who will be inducted into office at the annual meeting, to be held next week in Toronto.

Biographies of each of these engineers, prepared in each case by an engineer who has been in intimate professional relation with the subject of the biography, are printed below.

Frederic P. Stearns: President of the American Society of Civil Engineers.

By John R. Freeman, Past-Pres. Am. Soc. M. E.

The life of Frederic Pike Stearns presents a fine example of a young man of strong character, high purpose and a love for constructive engineering, coming from a small country town to a great city, finding a place in the City Engineering Department, and, by fidelity to detail, inviting rapid promotion. Quietly meeting every new responsibility with a steadfast spirit of thoroughness, he has been so obviously the man for the place when new positions requiring engineering skill and original treatment have been created in the ever-increasing scope of municipal work, that during the past 25 years an important share in the large public works of the Boston Metropolitan district has come to him, unasked. In the course of all this work he has won the friendship of those under him, of those over him and of engineers working in parallel lines. All along he has given freely of his time in helpful discussion with younger engineers, and has found time to attend the meetings of the local engineering society and to take a lively interest in its welfare. To-day no engineer stands higher in the warm personal friendship and professional esteem of the engineers of New England than the President-elect of the American Society of Civil Engineers.

Mr. Stearns did not have the training of a technical school, but was schooled in practice under such notable teachers as Joseph P. Davis, Alphonse Fteley, James B. Francis, Hiram F. Mills, Henry P. Walcott, Thomas M. Drown and William T. Sedgwick. Among his intimate friends and sometime fellow-students in this practical school were Howard A. Carson, now Chief Engineer of the Boston subways and the harbor tunnel; George S. Rice, now Chief Engineer of the New York subway; William Jackson, for twenty years past City Engineer of Boston; Charles S. Gowen, for ten years Resident Engineer in charge of building the Croton dam; Allen Hazen and George W. Fuller, now among the foremost few of American sanitary engineers; and others of that notable Boston group, whose calling together, if one knows how to trace it, may be attributed to the quiet initiative of James P. Kirkwood, Charles S. Storrow, James B. Francis, Joseph P. Davis and Hiram F. Mills.

In brief, the characteristics of Mr. Stearns' work have been a broad outlook, a faithful, thorough study of details, a persistent effort for the highest economy; but his economy has not been at expense of quality. On the contrary, the effort has been, first, to make sure of quality; then to review and make painstaking study of economy. On the Boston Metropolitan Water-Works, notwithstanding that engineering salaries were small, this persistent attention to detail made the engineering expenses large, but

the corresponding economy of construction and operation paid it back many fold.

Among Mr. Stearns' contributions to engineering design and sanitary science, perhaps ultimately it will be found that the most useful is the attention that he has directed to the safety and economy of earth dams of great size, of which a most notable example, built under his direction, is found in the great north dike of the Wachusett reservoir. The success and economy of design of this structure, restraining the waters of the greatest artificial water-works reservoir yet built, were deemed so instructive on the problems of the great dams, proposed in connection with the Panama Canal, that the International Board of Consulting Engineers, convened by President Roosevelt in September last, paid it an official visit of inspection.

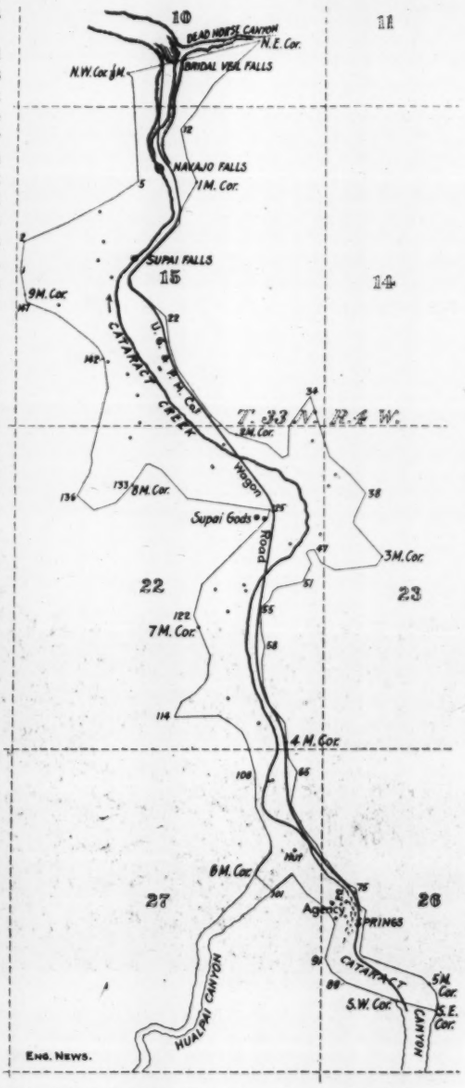
Another important lesson to engineers worked out under Mr. Stearns' supervision, from designs by F. L. Olmsted, at Weston reservoir and at Spot Pond, is found in the attention given to landscape architecture of the highest order for softening and beautifying the ordinary harsh contours of reservoir embankments. Eminent architects skilled in stately form and graceful line were likewise called in as collaborators in the design of the pumping stations and gate houses, engineer and architect working together, each within his limit of best efficiency, with a result that the structures are of rare beauty and in strict harmony with their use.

Confining our attention to the notable incidents in Mr. Stearns' career, he was born Nov. 11, 1851, in Calais, Me., a lineal descendant of Isaac Stearns, who came over from England in 1630, a member of Gov. Winthrop's party, and settled in Watertown, Mass. Mr. Stearns attended the public schools of Calais, and in 1869 came to Boston, found employment in the City Surveyor's office, and at once began to spend his spare hours in scientific study.

In 1872 he was assigned to duty on the corps organized for investigations upon an additional water supply for Boston. These investigations were under the general direction of Joseph P. Davis, whose eight-year incumbency of the Boston City Engineer's office is looked on as the golden age of that office, with traditions that have been continued for the past 25 years under his former lieutenants.

In 1880, on completion of the aqueduct, Mr. Stearns was transferred to the extensive works then under construction for the main drainage of the city of Boston, and under Eliot C. Clarke was given, as division engineer, immediate charge of the construction of the tunnel under Dorchester Bay and of the reservoir and outfall works on Moon Island, in Boston harbor. On the completion of the works he became executive engineer in direct charge of the entire system, continuing still on the staff of the City Engineer.

In 1886 he was detailed to collect engineering data and to assist a commission, consisting of James B. Francis, Eliot C. Clarke and Clemens Herschel, in their studies of the safeguarding of the Stony Brook Valley from disastrous floods. In 1886 he resigned from the staff of the City Engineer to become the Chief Engineer of the Massachusetts State Board of Health, and continued on that board, engaged on a great variety of investigations, dealing mainly with water supply and sewerage problems, until 1895. The work of this board, under the guidance of Dr. Henry P. Walcott and Hiram F. Mills, C. E., had been developed on such very broad engineering lines that it soon became the foremost board of its kind in this country, and perhaps in the world. A remarkable series of investigations upon the natural purity and the pollution of the rivers of the State of Massachusetts was undertaken. These naturally led to studies of filtration for making waters potable and to studies of such purification of the effluent sewage that it might be safely turned back into a flowing river. The work of the State Board of Health was of such high order and on such broad lines of public spirit that it soon established itself in the confidence of the Legislature to a remarkable degree. Liberal appropriations for research were given it, and the question of what source any municipality or private company might take for purpose of public water supply turned mainly on the report of the State Board of Health. Other large problems of sanitary engineering were given it, and the details of the majority of engineering investigations fell to Mr. Stearns. Chief among these were studies for disposition of the sewage of the populous valleys of the Mystic and Charles rivers, and study of the improvement of the Charles River basin, so that, by means of a dam and tidal lock, the tidal estuary, with its unsightly mud flats exposed at low tide, might be transformed into a beautiful fresh-water lake. This,



Survey Map of Yava-Supai Indian Reservation, Arizona, as made by James B. Girand.

for years a dream, is now under construction, with Mr. Stearns as consulting engineer.

Meanwhile, in 1889, Mr. Stearns acted as a member of a board of sanitary engineers to devise a system of sewerage for the District of Columbia, and in 1892 he also acted as consulting engineer for a commission appointed to study the rapid transit problem of Boston. His last work, under the State Board of Health, was in charge of an investigation upon a water supply for the Boston Metropolitan district.

In 1895, on the appointment of the Metropolitan Water Board, Mr. Stearns was promptly selected as its chief engineer. His past 10 years has been occupied in building these great works, which supply water to Boston and 19 of the surrounding cities and towns. It is worthy of note that until these works were substantially completed he steadfastly declined many attractive offers of consulting work on outside problems, in order that he might give his whole time and strength to these studies. The works constructed during these 10 years, and now operated under his supervision, constitute what is probably the most noteworthy series of water-works structures in the United States, foremost, not altogether in size, but in perfection of detail and the embodiment of the very best practice in hydraulic engineering throughout, from reservoir to pumping station. The entire bottom of the great Wachusett reservoir, 6½ sq. miles in area, to an average depth of about 12 ins., was stripped of all loam, grass roots or mud, in order that it might be more sterile and furnish less decaying vegetation and consequent food for those algae which at times impart bad taste to waters. This material was used largely for the construction of the great earth dikes. Spoil banks along the channels leading to the system were at small expense trimmed to the contour of natural hillocks, adding to the beauty of the scene instead of marring it, as they so often do, and in its pumping stations are found engines giving in daily service the highest average duty yet attained.

Mr. Stearns is at the present time Chief Engineer of the Metropolitan Water Board; Consulting Engineer to the Boston Charles River Basin Commission; Consulting Engineer to the city of Baltimore on its sewerage system, a member of the Board of Consulting Engineers on the Isthmian Canal, and one of the Consulting Engineers on the New York Board of Water Supply.

Mr. Stearns has been a member of the Boston Society of Civil Engineers since 1882, and of the American Society of Civil Engineers since 1878. He was President of the Boston Society in 1891, Director of the American Society in 1893-5, Vice-President in 1898-9, and has long been a prominent member of the New England Water-Works Association. He has taken great interest in all of these societies, and frequently contributed to their publications. His more important contributions to the American Society of Civil Engineers are that written jointly with Mr. Fteley in 1883 on "Experiments on the Flow of Water Over Weirs and in Conduits," for which the Norman Medal was awarded; in 1883, a paper on the "Current Meter"; in 1884, "Experiments on Flow in a Forty-Eight-Inch Pipe"; in 1902, "Description of the North Dike of the Wachusett Reservoir"; and to the Boston Society of Civil Engineers, in 1891, a paper of broad usefulness, "On the Selection of Sources of Water Supply."

Harvard University, in 1905, on commencement day, conferred upon Mr. Stearns the honorary degree of Master of Arts.

Mr. Stearns' family consists of a wife and two sons. Both of these sons are graduates of the Massachusetts Institute of Technology, and are civil engineers actively working their way up in the footsteps of their father, one on the tunnel work of the Boston subway extension, the other on the construction work of the Metropolitan sewerage system.

Frederick Winslow Taylor: President American Society of Mechanical Engineers.

By H. F. J. Porter,* M. Am. Soc. M. E.

Frederick Winslow Taylor was born in Germantown, Pa., in 1856. After securing his early education in Philadelphia and in Germany, he went to Phillips' Academy, at Exeter, N. H., where he prepared for college. At the age of 18 he entered Harvard in the class of 1873. Shortly after beginning his college course he discovered that his eyesight was impaired and was advised to discontinue study. Disappointed at not being able to carry out the plan which he had formulated of laying a broad foundation for a subsequent professional training, he returned home, determined to apply himself to securing practical experience in the trades which pertained to his proposed profession of engineering, and at the same time to develop his physical strength until his eyesight should become sufficiently restored to resume his studies.

With this intent, he apprenticed himself in the pattern shop of a small pump works in Philadelphia. Finding that, on account of the superior

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advantages which he had enjoyed over his fellow apprentices, he could make more rapid progress than they, he made especial arrangements with his employers to work in the machine shops, also, so that in the four years allotted to him he qualified as journeyman not only in pattern making but also as a machinist.

The dull period existing in 1878 offered him no attractive opening in either trade, and he accordingly engaged as laborer in the machine shop of the Midvale Steel Co., in Philadelphia, thus seizing an opportunity to be on hand should a vacancy materialize in the ranks above.

His ability to perform work of a higher order soon made itself apparent, and he was quickly promoted to the position of shop clerk, and soon afterwards put in charge of the tool room. Observing here the great amount of time wasted by each workman in grinding his shop tools, he advocated the assignment of one man to this duty, and subsequently invented the Taylor grinder for the purpose of doing the work more accurately and rapidly than it had been done before.

From his position in the tool room his promotion was rapid. He became in turn gang boss, assistant foreman and foreman of the machine shop. His originality in emergencies having become appreciated, he was next appointed master mechanic in charge of repairs and maintenance of the works, and then successively chief draftsman and chief engineer. This rise from the lowest to the highest position in the technical staff of the works occupied six years, and probably could not have been accomplished solely by the elementary knowledge of mechanics he possessed when he entered the works as laborer. Appreciating that in order to advance he would have to acquire an acquaintanceship with the principles of higher engineering practice, he (in 1880) began to study at night the engineering course as prescribed by the curriculum of the Stevens Institute of Technology. By diligent application, in three years he completed the four years' course, and, passing his examinations, graduated in 1883 with the degree of M. E.

Mr. Taylor left his impress on every position as he held it in passing through the works, and when he went from there, in 1890, the design of a great part of the plant and machinery was his. The steam hammer, with which the large forgings were made, the largest steam hammer then built, with a capacity of 50 tons impact, was designed, patented and built by him on an entirely new and original principle.

Mr. Taylor possesses a keen power of observation and an unusual ability to analyze situations and to draw deductions. In his passage through the various positions which he held in the works he made a study of the methods of management, as imposed upon him and his fellow workers, and whenever he was able to improve upon them he did so. This study was the beginning of what subsequently became his specialty—the development and application of the science of shop organization and management. Up to this time this subject had not reached the dignity of an art. It was supposed to be a qualification inherent in a man if he proved to be a successful manager, and that any methods which he might apply would be correct. Mr. Taylor realized while he was a foreman of the machine shop that the great contention between employer and employé lay in the amount of work that a man ought to accomplish in a day.

He soon decided that very little was known on the subject, and began to make accurate determinations for himself by means of scientific time studies with a stop watch. Observations were taken, not occasionally nor at random, nor without the knowledge of the workman, but with the hearty co-operation of the latter, and continuously for long periods of time. By this method he was able to determine that the amount of work a good man could do daily and continuously, not only without detriment to himself physically, but much to his betterment as well, was from two to three times what was then supposed to be a fair day's work, and that this increase in efficiency could be obtained by an increase in salary of from 25 to 100%.

In 1890 Mr. Taylor left the Midvale Steel Co. to become general manager of the Manufacturing Investment Co., operating large paper pulp mills in Maine. After serving the term of his contract of three years with this company he began, as consulting engineer, to introduce his principles of organization and management into various industrial establishments about the country.

In the prosecution of this work he has made many improvements in machinery and labor-saving appliances, a large number of which he has patented. A striking example of the effectiveness of his methods occurred at the works of the Bethlehem Iron Co. (now Bethlehem Steel Co). In 1898 this company possessed a machine shop which, although the largest in this country, was unable to keep pace with the forge department of the works. The erection of another similar shop was seriously contemplated at a cost of approximately $1,000,000. Before taking this action it was decided to adopt every available means to increase the output of the machine shop then existing. Mr. Taylor's success in developing efficiency of tools and organization having been demonstrated to the satisfaction of the board of directors he was engaged to solve the problem in the best manner possible.

His first effort was to establish a standard grade of tool steel on which to base a tabulation of the work performed by the various workmen. In this search, which was made conjointly with Mr. Maunsel White, Engineer of Tests, the usual scientific methods which Mr. Taylor always practiced were adopted, and a discovery was made which resulted in what was termed the "Taylor-White Process" of heat treatment, whereby tool steel of a certain composition attained a cutting efficiency of 100 to 200% higher than any other tool steel known. This discovery created a great deal of comment at the time, and was characterized by men of high standing in the steel industry as the greatest development in the industry since the Bessemer process. It was looked upon as the only illustration of marked recent advance at the Paris Exposition of 1900, where it was first brought to the attention of the public. Since then it has been adopted by every machine shop of any standing the world over, and has not only universally revolutionized machine shop practice, but has also caused a change in designs in the machine tool industry to meet the new conditions imposed upon machines which serve to apply power to the work of cutting metals.

In the machine shop where the discovery was made the changes brought about by its development, together with the improvement in shop methods introduced by Mr. Taylor, resulted in an increased production of over 500%, so that not only was the necessity of building a new machine shop obviated, but the necessity actually arose of building an addition to the previously spacious forge in order to balance the two departments.

Mr. Taylor's scientific methods of shop management have been fully described in monographs presented to the American Society of Mechanical Engineers, entitled "A Piece Rate System" and "Shop Management," in which are described original and accurate means of ascertaining cost of product, together with the principles of "functional foremanship" in contradistinction to the military organization that ordinarily exists in industrial plants.

Mr. Taylor recently published, conjointly with Mr. Sanford E. Thompson, a book of 500 pages on "Concrete, Plain and Reinforced," which is the most comprehensive treatise on the subject so far issued. He is now engaged in writing a book covering his contributions to the science of shop management, to the issue of which the industrial world is looking forward with much pleasurable anticipation.

Dr. Schuyler S. Wheeler: President American Institute of Electrical Engineers.

By Francis B. Crocker,* Past-President, American Institute of Electrical Engineers.

Schuyler Skaats Wheeler, Sc. D., the recently installed President of the American Institute of Electrical Engineers, was born of Dutch descent in New York City in 1860. He was educated in the schools of his native city and in Columbia College. Leaving that institution in 1881, he was employed as assistant electrician of the American branch of the Jablochkoff Electric Light Co., the first commercially important electric lighting enterprise in the world. Later he became connected with the United States Electric Light Co., another pioneer in the electrical field, exploiting the inventions of Mr. Edward Weston.

At this time the first central station for incandescent lighting was being installed in Pearl Street, New York City, by Mr. Edison; and Dr. Wheeler, although then only 21 years of age, took a prominent position on the staff not only in laying and testing the system of underground conductors, the first of its kind, but also in the starting of the station. This was an event of great importance in the history of electrical engineering, being the beginning of the distribution of electrical energy at constant potential by the parallel system. Before that time constant current, series arc lighting was the only developed branch of the electrical industry outside of telegraphy and telephony. The present methods of electrical distribution for lighting, stationary and traction motors, as well as for electrometallurgical purposes, have all followed along the lines originally laid down by Edison.

Dr. Wheeler was afterwards promoted to be chief electrician of the Pearl Street station. As a result of his experience in New York City, he was put in charge of the laying of the underground conductors of the Edison Company in Newburgh, New York, and remained there for some time as superintendent.

In 1886 Dr. Wheeler was selected as electrician of the Herzog Teleseme Co., in which position he showed his inventive ability by contributing several ingenious and permanently important features to the signaling apparatus of that company.

Early in the following year the C. & C. Electric Co. was organized by Mr. Charles G. Curtis (the inventor of the Curtis steam turbine), and the writer, both of whom had been close friends of Dr. Wheeler from boyhood. He became associated with us in the work of designing and manufacturing the motors brought out by that company, and soon became factory manager. It was in this position that his talents had an opportunity to show themselves under favorable conditions. The rare combination of technical knowledge with business ability which Dr. Wheeler possesses to an eminent degree is exactly what is required for success in manufacturing, especially in new lines. Differences in regard to the policy of the C. & C. Company arose, and Messrs. Curtis and Wheeler, as well as the writer, all severed their connection with it.

During the year 1888 Dr. Wheeler and the writer undertook the design and manufacture of new types of electric motor as a personal enterprise, under the firm name of Crocker & Wheeler. This work was so successful that the Crocker-Wheeler Electric Motor Co. was founded, afterwards becoming the Crocker-Wheeler Company, with which corporation both of its founders still remain closely identified.

About the time of the organization of this company, Dr. Wheeler was appointed Expert of the Board of Electrical Control of New York City. His duties were of the most difficult and responsible character. On one hand were the great telegraph, telephone and electric lighting corporations struggling to maintain their labyrinths of overhead wires and on the other hand the City Government, pushed on by the general public, was demanding that the wires be put underground, in some cases actually chopping down the poles. This warfare at first brought upon Dr. Wheeler the ill-will of the companies in conflict with the municipal authorities; but before the work was finished he had turned this ill-will into confidence and respect by his fairness, which really protected the electrical interests of the city.

As a result of the growth of the Crocker-Wheeler company and the appointment of the writer as head of the Electrical Engineering De-

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partment of Columbia University, Dr. Wheeler resigned from the Board of Electrical Control and gave all of his time to the company, of which he became President and General Manager. In 1892 the factory was moved to East Orange, N. J., a special station on the Lackawanna Railroad being opened and named "Ampere," in honor of the great French electrician after whom the unit of electrical current is named.

Three years later the works were totally destroyed by fire, and it was in this emergency that Dr. Wheeler showed his great energy and resourcefulness. In tents and temporary sheds, electrically driven tools were operated immediately after the fire, so that orders were filled and the business kept up. His abilities as an organizer and executive were also very effective in rebuilding and extending the Crocker-Wheeler Company's works, which have continued to grow rapidly, the company being now one of the prominent producers of electrical machinery, including direct as well as alternating current generators and motors.

Dr. Wheeler is endowed with a natural engineering mind, that seems to rise above calculations, and determine intuitively the principles involved in an engineering problem and their true relation to each other. At the same time he has the ability to grapple with a mass of details and sort them out so that none escapes. After much observation and study, and assisted by expert accountants, he devised and put into thoroughly successful operation a production and cost system for keeping account of every item of labor and material in all unfinished as well as finished product. It includes a complete system of specification-writing by the drafting department, order-issuing by the production department, requisition-issuing by the purchasing department, and reporting of receipts and deliveries by the receiving and stock departments. The result is that a factory order once booked follows its course almost automatically. Its execution, involving the labor of hundreds of workmen and the drawing or purchasing of perhaps thousands of items of stock, is not subject to the discretion or care of anyone.

Dr. Wheeler's force of character, as well as his ability, were well illustrated in his vigorous and successful handling of the machinists' strike, of which Ampere was the Eastern storm center. He was not only determined in his attitude, but also carefully attended to the many matters and details involved, or what might be called the strategic conditions, in a masterly way, which gave him victory complete and lasting. For example, he provided his remaining and new workmen with food and lodging, and these were of much better quality than the men were accustomed to.

From the foundation of the American Institute of Electrical Engineers up to the present time, Dr. Wheeler has played an active and prominent part in its affairs. Before his election to the presidency, he served several terms as vice-president, manager, and as member of its various committees. His interest in the Institute, as well as his liberality, are well illustrated by his purchase and presentation of the Latimer Clark library, the most complete collection in the world of early and rare electrical books. He has given much of his time and the benefit of his business judgment to the plans and arrangements for the Carnegie Engineering Building, which is now being erected in New York City for the joint use of the great national engineering societies, and he is the Treasurer of the United Engineering Society, which has general charge of this building. He is also chairman of the Building and Technical committees of the Automobile Club of America, and is keenly interested in the touring side of the sport, having been one of the first to use the automobile extensively as a traveling carriage abroad.

As an author Dr. Wheeler has contributed a number of articles to magazines and technical journals. In conjunction with the writer he is also the author of a book on "Practical Management of Dynamos and Motors," of which several editions have been published.

As a recognition of his work, Hobart College conferred upon him in 1888 the honorary degree of Doctor of Science. For many years he has been a full member of the American Society of Civil Engineers, and of the American Society of Mechanical Engineers. He is also a member of the University, Riding and Lotus Clubs of New York, the Chamber of Commerce of New York, and of other organizations.

Hugh David Lumsden: President of the Canadian Society of Civil Engineers.

Since Canada is now entering upon a new era of railway building, it is fitting that the Canadian Society of Civil Engineers should elect as its president a man the principal part of whose professional life has been devoted to railway engineering, and who now holds the important position of Chief Engineer of the Transcontinental Railway of Canada (Eastern Section).

Hugh David Lumsden, the youngest son of Col. Thomas Lumsden, C. B., was born at Belhelvie Lodge, Aberdeenshire, Scotland, on Sept. 7, 1844. After being educated at Belleview Academy, Aberdeen, and at the Wimbledon School, Surrey, England, Mr. Lumsden settled in Canada, in April, 1861. He served an apprenticeship as a land surveyor at Woodville, Ont., until 1864, and was engaged in private practice in Woodville until 1870. In that year he was elected Reeve of the Township of Eldon and also President of the Agricultural Society of Eldon.

A long line of engagements on Canadian railway surveys, interspersed later on by construction work, was begun by Mr. Lumsden in 1870. From October of that year to April, 1871, he was in charge of the location of a portion of the Toronto & Nipissing Railway, under Edmund Wragge, C. E., and later in 1871 he occupied a similar position on the Toronto, Grey & Bruce Railway. His following engagements, up to 1881, may be summarized as follows: In 1872, in charge of location surveys for the Northern Railway at various points; 1873 to 1874, Engineer-in-Charge of location surveys, Credit Valley Railway; May, 1875, to June, 1876, in charge of survey parties for the contractors of the Georgian Bay Branch of the Canadian Pacific Railway, between mouth of French River and Lake Amabeldufond, Wm. Murdock being Chief Engineer; 1876 to 1879, in charge of surveys and construction for the Dominion Government of the Georgian Bay Branch of the Canadian Pacific Railway; May, 1880, in charge of parties on the Canadian Pacific Railway through the Northwest Territories. In March, 1881, Mr. Lumsden became Chief Engineer of the Ontario & Quebec Railway, which position he held until November, 1884. Then for practically ten years he was almost constantly in charge of the location and construction of various works for the Canadian Pacific Railway. These included the Short Line through the State of Maine; the line from Smith's Falls to Vaudreuil; a portion of the Ottawa Short Line; supervision of the line from Regina to Prince Albert; Calgary to Edmondton and Calgary to McLeod; also Crows' Nest Branch, from Lethbridge to Kootenay Landing, and several branch lines in Manitoba.

Since August, 1904, Mr. Lumsden has been Chief Engineer of the Eastern section of the Transcontinental Railway, his section extending from Moncton, N. B., to Winnipeg, Man., a distance of some 1,890 miles. As most of our readers know, this railway is to be built by the Canadian Government, and, with an extension from Winnipeg to some point on the Pacific, will form a new railway from ocean to ocean, much of all existing lines on the Continent of North America. The transcontinental surveys carried on under Mr. Lumsden's direction would, if properly described, form one of the most interesting chapters in the history of railway exploration. A large percentage of the line runs through country rarely traversed heretofore by any one save the Indian and the trapper, with no organized means of transportation in existence at the time the surveys were begun, and with none possible, for the present, except the back of the packer and canoes in summer, supplemented by sleds, with or without dogs, in winter.

Mr. Lumsden was married on Oct. 28, 1885, to Mary Fredrica, only daughter of J. W. G. Whitney, of Toronto, Ont. He was elected a member of the Institution of Civil Engineers in 1885 and of the Canadian Society of Civil Engineers in 1887.

POWER PLANT OF THE CHICAGO DRAINAGE CANAL.

The project for the utilization of the water-power developed by the flow of the Chicago Drainage Canal was described in our issue of Jan. 12, 1905, at which time the construction had been actively commenced. The work comprises three sections: 1st, the head race from the present terminus of the canal at Lockport to the power-house; 2d, the tail race from the power-house to the Desplaines River, at Joliet; 3d, the power-house. Auxiliary to the third section are three other works: (A) a bear-trap dam to carry away floating ice and drift; (B) a lock, 22 x 130 ft., for canal boats, so that the Illinois & Michigan Canal can be abandoned between Chicago and Joliet; (C) provision for a large ship lock, 80 x 600 ft., and with a lift of 34 ft., in the event of the canal being utilized for navigation in connection with the proposed "deep waterway" from the Lakes to the Mississippi River. A transmission line will convey current to a substation in Chicago, from which it will be distributed for arc lighting and for operating induction motors. Mr. Isham Randolph, M. Am. Soc. C. E., is Chief Engineer, and for plans, etc., we are indebted to Mr. G. M.

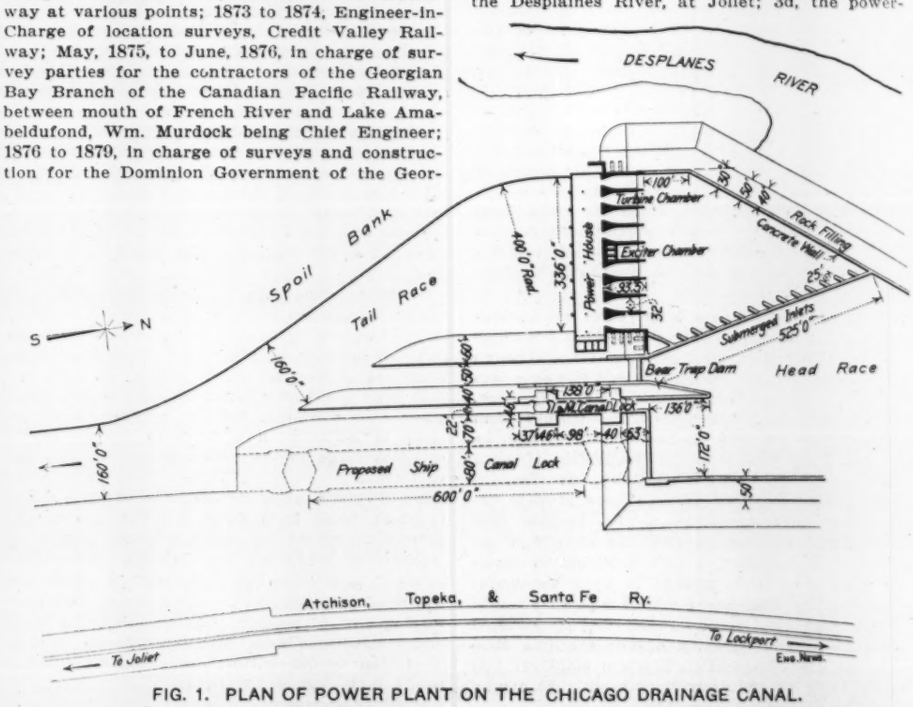


FIG. 1. PLAN OF POWER PLANT ON THE CHICAGO DRAINAGE CANAL.

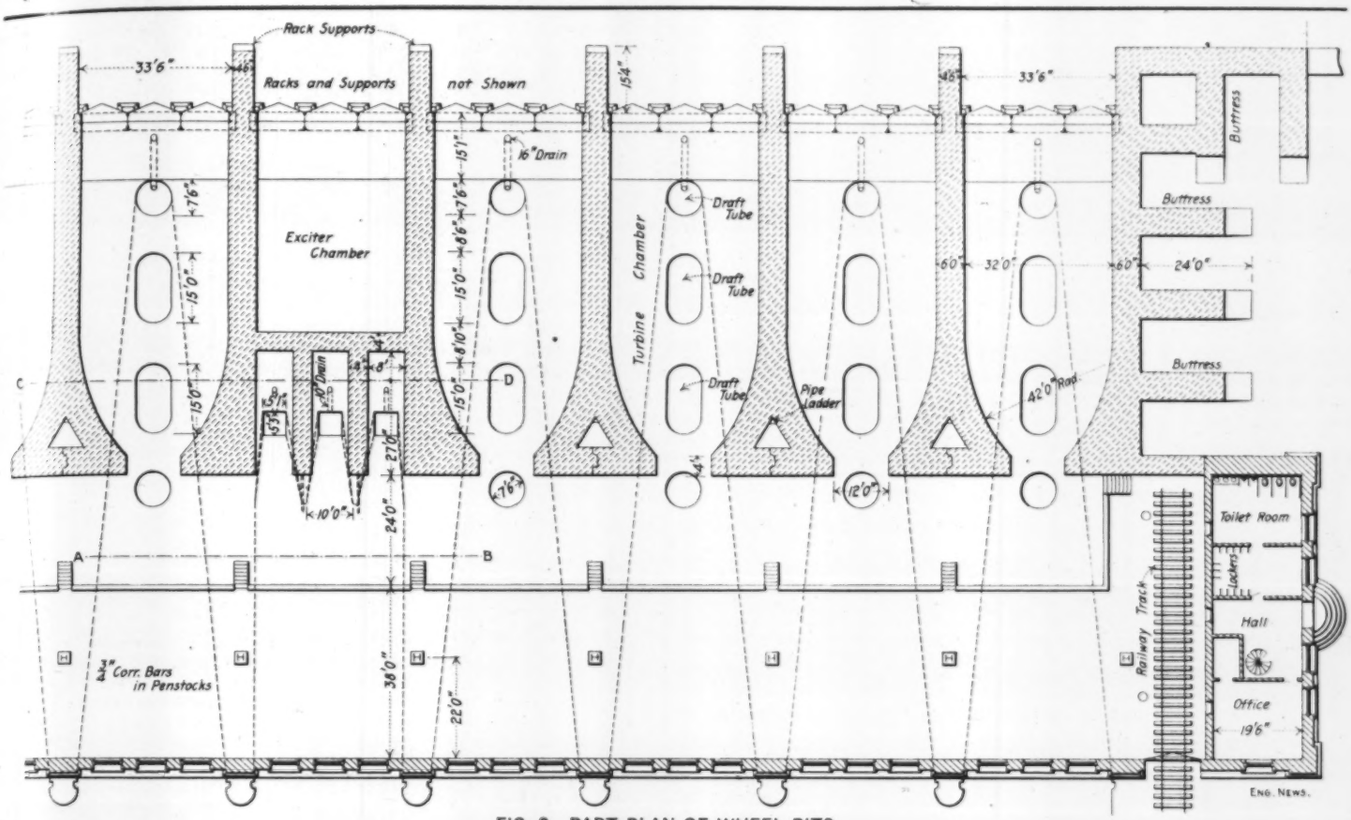


FIG. 2. PART PLAN OF WHEEL PITS.

Wisner, who is acting Chief Engineer during Mr. Randolph's absence while serving on the Board of Consulting Engineers for the Panama Canal.

In the present article we deal particularly with the power-house, which forms a separate contract, including the bear-trap dam and the boat canal lock. Much of the information given below was obtained during a recent visit to the work in the company of Mr. L. K. Sherman, Resident Engineer. The Hayes Bros. Co., of Janesville, Wis., has the contract, and will probably have the work ready for the installation of the machinery by the end of next summer.

The general arrangement is shown by the plan, Fig. 1. The head race, 100 ft wide, extending from the basin at the end of the present canal (at Lockport) is widened to about 600 ft., of which the main dam and power-house represents nearly 400 ft. A concrete wall running from the outer end of the dam diagonally across the basin forms the head bay, and has submerged openings, or inlets, the intrados of the arches being 12 ft. below Chicago datum. This will protect the wheels from floating ice and drift, which will be discharged over the bear-trap dam.

The plan and cross section of the power-house and wheel pits are shown in Figs. 2 and 3, and in the latter the normal water level is 8 ft. below Chicago datum. Sections of the tail pits are shown in Fig. 4. There are eight wheel pits and one exciter pit, divided into three compartments. Each pit has four draft tubes for the six wheels mounted on one shaft, and the tubes discharge into the arched openings, passing under the power-house to the tail race. Across the entrance to each pit are the racks to exclude any ice or drift that may pass through the submerged

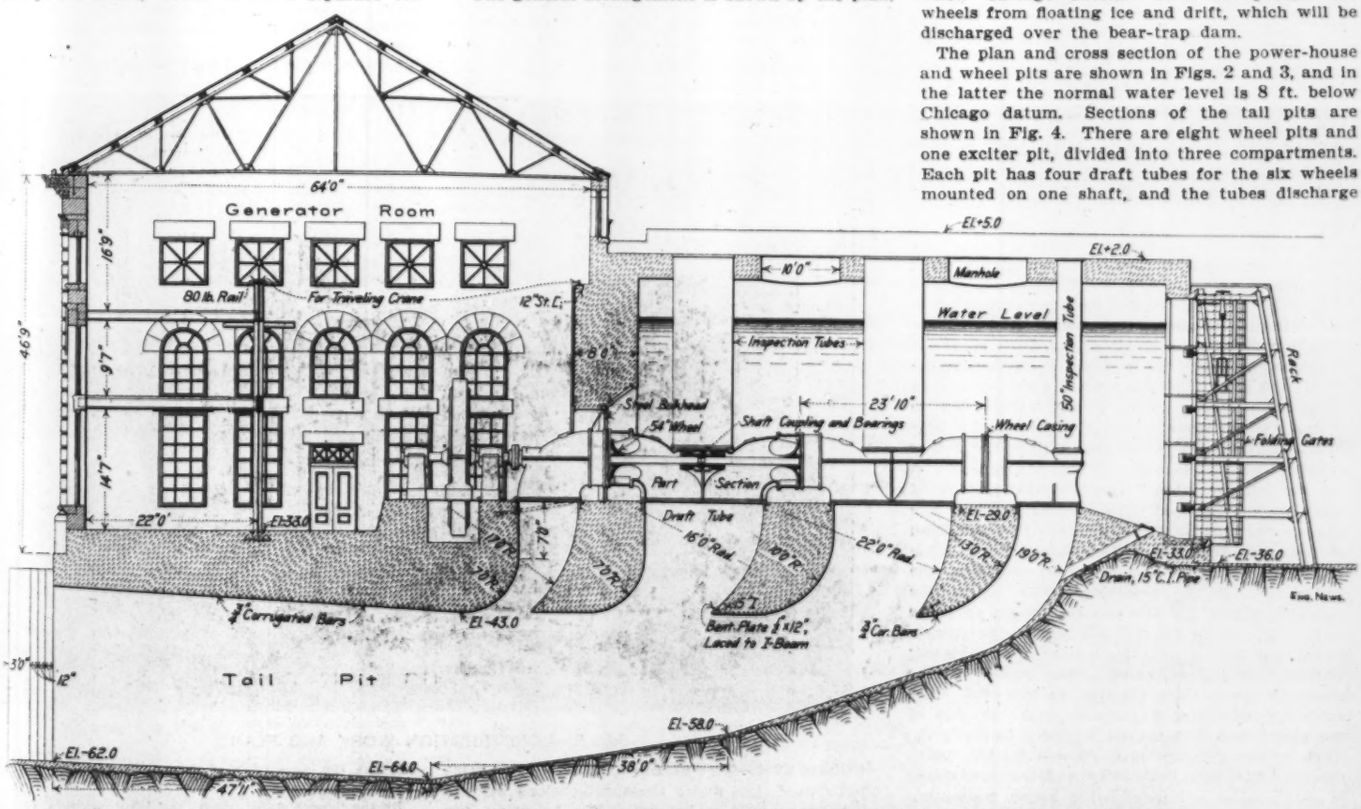


FIG. 3. CROSS-SECTION OF POWER HOUSE AND WHEEL PITS, SHOWING POSITION OF MACHINERY.

openings, and behind these are folding gates, which can be closed to shut off the water and allow access to the wheels. Any water leaking through these doors is taken care of by a 16-in. cast iron drain pipe embedded in the concrete and discharging into the first draft tube. The pile at the right and the concrete mixer at the left. The pit in the middle of the view is being excavated, while the one at the left has the forms in place and the concrete lining partly filled in. Above this is the high concrete wall of the forebay. Fig. 6 show two of the pits, with the forms

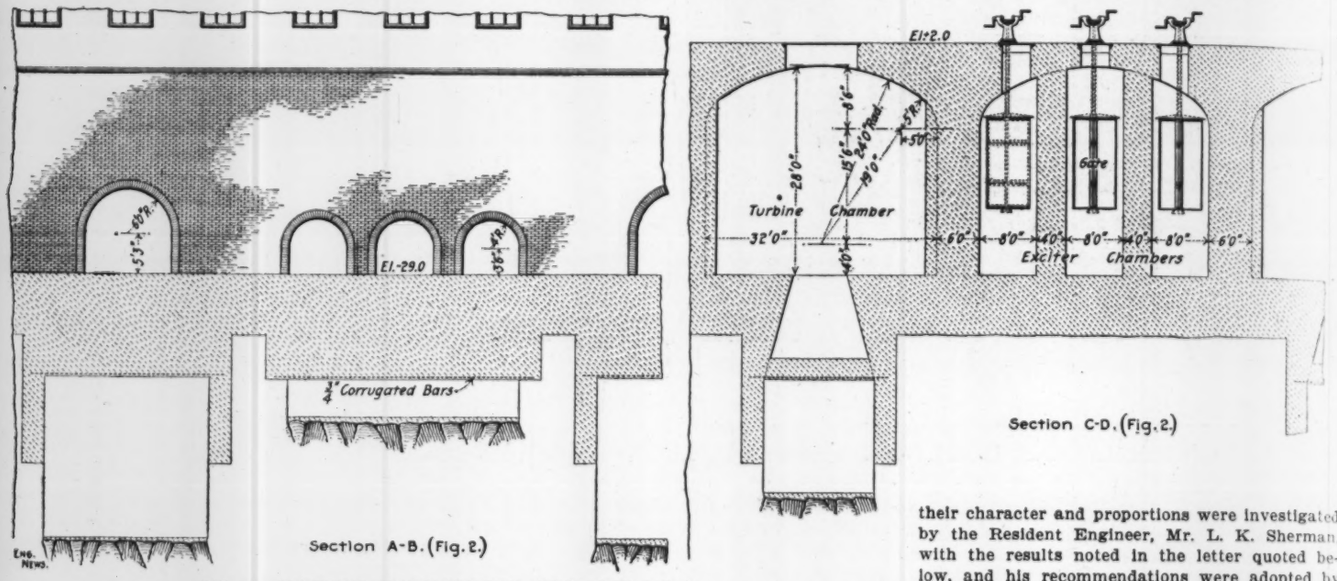


FIG. 4. SECTIONS THROUGH TAIL PITS (SEE FIG. 2).

work was designed by Mr. Albert S. Crane, Hydraulic Engineer.

CONSTRUCTION WORK.—The excavations for the wheel pits and for the foundations of the dam and power-house are in the Joliet limestone. This is fairly solid, but contains a number of springs which required special attention, and also developed some deep clay pockets running (as on other parts of the canal) from southwest to northeast. The pockets are from 2 ft. to 10 ft. wide and consist of a stiff blue shaly clay, which gradually softens when exposed to air and water. In order to prevent the possible blowing out of the clay under the walls in the future, when softened by prolonged exposure, concrete cut-off walls are carried down 15 or 20 ft. into the clay, and where the surface of the clay is exposed it is excavated and covered with a floor of concrete. The head race is mainly above the level of the ground and is formed by concrete retaining walls (without reinforcement) backed by embankments of loose stone from the excavations. The tail race involves heavier excavation.

The power-house is formed as an integral part of the dam and has concrete foundations on the solid rock. The wheel pits are also excavated in the rock and were outlined by Sullivan channeling machines before any blasting was done, so as not to disturb the rock of the piers or abutments between the pits. The pits are all faced with concrete, about 36 ins. thick, worked with spades to give a smooth surface finish. There was a considerable amount of water met with in the deeper excavations, and in order to lay the concrete in the dry, drains were formed in the surface of the rock and covered with wooden boxing. The dump cars, filled by a steam shovel in the bottom of the excavation, were hauled out on a cable incline at one side and taken in trains to the dumps behind the retaining walls or to the crushing plants for the concrete work on these walls. The stone for the concrete of the power-house was loaded into the bucket of a cableway 400 ft. long and delivered either directly to the stone bin or to cars running to this bin. This cableway was placed parallel with the line of the canal, and was moved laterally to serve the work at the different pits. Steam for the channelers, drills, hoist, cableway and concrete mixer is generated at a central boiler house, containing two boilers of 100 HP. capacity each, and distributed by pipes, the greatest distance from boiler to work being about 400 ft. Fig. 5 shows the steam shovel in the bottom of the pit, and the cableway above it, with the crusher and stone for the concrete lining, and also the forms for the draft-tube openings.

The concrete mixer used on this contract is of the batch type, invented by Mr. J. W. Page, and described in our issue of Dec. 7. It has an open pan, or drum, 8 ft. diameter and 4 ft. deep, mounted on a shaft set at an angle of about 52° with the vertical, and driven by spur and bevel gearing from a two-cylinder reversible vertical engine of 20 HP. The concrete is made in batches of 30 cu. ft. and discharged through a door in the side into dump cars on a track beneath. A water pipe is carried above the machine, with a branch projecting into the drum.

FIG. 5. CONSTRUCTION WORK AND PLANT.

CONCRETE.—Two grades of concrete are principally used, and under the specifications were to be proportioned as follows: No. 1, where the work is required to be watertight, a mixture of 1 cement, 2½ sand or limestone screenings and 4½ broken stone; No. 2, for filling and backing, the mixture is 1—3—6. The mixture is made moderately wet. The specifications required the stone to be not larger than 1½ ins., and the screenings not larger than ⅛ in., the amount of crusher dust to be subject to the direction of the engineer. Both stone and screenings are the product of the crushed limestone from the excavations, and their character and proportions were investigated by the Resident Engineer, Mr. L. K. Sherman, with the results noted in the letter quoted below, and his recommendations were adopted by the contractors, the actual proportions now being as follows: No. 1, 1 cement to 4.46 screenings (of which 44% is classed as stone) and 3.53 stone; No. 2, 1 to 5.38 to 4.94.

The screenings from your crusher are composed of 56% which will pass a No. 6 sieve, and 44% which is held by a No. 6 sieve, or which is composed of grains larger than the specified ¼-in. I consider this 44% as so much broken stone. My experiments show that mixtures of about 1 part of the rejected screenings to 2 parts of your regular broken stone form a volume equal to 82% of the sum of the two materials measured separately. In order to make a concrete which will contain the specified proportion of fine materials, and which proportion is essential in order to make mortar which will fill the voids and form a smooth face, it is necessary to increase the proportion of screenings and decrease the broken stone.

By the figures stated above, the 1:3:6 concrete, if made of screenings and stone, would have to be proportioned 1 cement to 5.38 screenings and 4.94 broken stone. This composition would give 3 parts of fine screenings, and the 2.38 coarse screenings plus 4.94 stone will give 6 parts stone. The 1 to 2½ to 4½ concrete would have

to be proportioned 1 cement to 4.46 screenings and 3.53 broken stone in order to get sufficient fine stuff under ¼-in., and as the concrete is for watertight work it is essential to have the full specific amount of fine stuff.

I do not consider that screenings, unless sifted to ⅛-in. size, would be satisfactory for No. 1 concrete, and I do not think it would improve matters to crush any finer, as the ¼-in. size already contains 12½% of dust.

FIG. 6. TWO OF THE PITS, WITH FORMS FOR DRAFT TUBES.

POWER-HOUSE OF CONCRETE BLOCKS.—This building is notable in that concrete block construction was adopted for both plain and ornamental work. As already noted, the power-house and dam form practically one structure. The north wall, which is the dam proper, is of concrete; the south and end walls will be of concrete blocks. The roof will have steel trusses, with plank sheathing covered with asphaltum-felt, and red tile. The walls, built of blocks, are 37 ins. thick at the base and at pilasters and 28 ins. at the top and between pilasters, and are composed of T-shaped blocks on the system of the American Hydraulic Stone Co., of Denver, Colo. Fig. 7 shows the arrangement of the blocks, and at window and door openings the air spaces will be filled with concrete so as to form solid blocks. The specifications for this concrete block work are as follows:

The concrete blocks to be used in the side walls and partitions are to be hollow and of a pattern approved by the engineer. The air space shall be between 30 and 50% of the total volume of the concrete and air. The concrete is to be made of Portland cement and sand, gravel or broken stone of such proportions as will give a strength to the block per square inch equal to that of blocks made by the American Hydraulic Stone Co.'s process. The exposed faces of the blocks are to have smooth surfaces similar to "rubbed" faces of ashlar masonry. This is to be accomplished by using a facing ¼-in. thick of mortar made of 1 part of Portland cement and 2 parts of sand. The body and face of the block are to be made at the same time and are to receive a pressure of at least 25 tons, which will bring water to the surface of the concrete.

All blocks are to be true in shape with clean, sharp arises. They are to be of such a design that at least 50% of the wall shall be of concrete. The bond between courses must be made so that no joints will come directly over one of the courses directly below it. The blocks of the exposed surfaces shall overlap, or break joint, to an extent of at least the depth of the course. A ¼-in. joint well filled with Portland cement mortar of a 1 to 2 mixture is to be used. The workmanship is to equal that of first-class ashlar masonry. As the work progresses all floor beams, windows, doors, piping, etc., are to be built in the work and left in a neat and workmanlike manner. When the masonry work is completed the exposed joints both inside and outside of the building are to be raked back for 1 in. and pointed to the satisfaction of the engineer.

The blocks used in the cornices, bases, capitals, window and door ornamentation, etc., are to have sharp, well defined edges and are to be provided with anchors sufficient to hold them securely in place. Where required, the exposed surfaces of the blocks are to be darkened by the use of lamp black.

All of the blocks which form exposed surfaces of the wall, both inside and outside of the building, are to be made of the same brand of cement and the same quality of sand, so as to give a uniform color to the blocks; and shall be made of 1 part cement, 2 parts of the specified sand and 4 parts of broken stone. The blocks used in the interior of the walls may be made of 1 part cement, 3 parts of sand and 6 parts of crushed stone. The cement, sand and stone are to be subject to the approval of the engineer and all stone used in making these blocks shall pass through a screen of ¾-in. mesh.

Each course of the outside face of the pilasters is to be made twice the depth of the courses in the main body of the wall, and is to be of one stone, so that there will be no vertical joints in the face of the pilasters. All other courses are to be at least 9 ins. high and of the same height.

The ordinary blocks are machine molded, but the blocks for the ornamental work, cornice, reveals, etc., the voussoirs for the window arches, and the large blocks for lintels, sills, pilasters, etc., are tamped by hand. The large blocks are also reinforced by plain round steel rods. The color is a light gray, and the face is of a close and even texture. The facing mixture is composed of Portland cement, hydrated lime and a waterproofing compound, mixed together, and then mixed with a white silica sand which will not absorb much water. The body of the block is composed of 1 part Portland cement to 6 parts of limestone screenings and dust not exceeding ½ in. in size. The blocks in the interior of the wall have no facing.

The blocks are made at the site, the plant comprising a 5-HP. gasoline engine, a Municipal concrete mixer of the cubical box type and a press for the ordinary blocks. To ensure straightness and accuracy in the large blocks, a large concrete floor was built, on which these blocks are tamped and left to set. The ordinary blocks taken from the press are placed on racks on drying cars and left under cover for 24 hours, after which they are removed to the curing, or storage, yard. A large number of blocks of all kinds have been made, but work was stopped as soon as the frosty weather began, and will not be resumed until next spring. With one machine and two molds, from 800 to 1,100 blocks per day have been made.

A 50-ton electric traveling crane will provide for the handling of heavy machinery in the power-house.

TURBINES AND GENERATORS.—The power-house is arranged for eight units, in two groups of four, separated by three exciter units. The present contract, however, is for four power units and two exciter units. Each of the 6,500 HP. power units will have six wheels, mounted on a 12-in. horizontal shaft, the shaft projecting through stuffing boxes in a steel bulkhead wall into the generator room and being coupled to the shaft of a revolving field, 60-cycle, three-phase generator. The normal head, as measured between the level of water in the turbine chamber and the tail race when all the wheels are running, is 34 ft., but under operating conditions the head may vary from 30 to 38 ft. The turbines are of the Jolly-McCormick type and will be built by the Wellman-Seaver-Morgan Co., of Cleveland, O.; the contract also includes two 600-HP. turbines for the exciters, with Lombard water wheel governors and the necessary gate operating mechanism. The specifications required for each power unit a discharge of 100,000 cu. ft. per minute, with 0.8 gate opening, the power not to be less than 5,000 HP. at such opening and the speed not less than 165 revolutions per minute. Each exciter unit must furnish not less than 600 HP. at full gate, with a speed of at least 300 revolutions. The efficiency of the turbines must be at least 80% from 0.75 to full gate when running at the required speeds, the same speed being maintained from 0.75 to full gate. On account of the great weight of the wheels and shaft and the serious consequences of lack of proper alinement, bearings lubricated by oil or grease were specified, the ordinary wooden bearing being allowed only in the exciter units.

The following description of the turbine plant has been furnished us by the builders:

Each of the power units is proportioned to discharge not less than 100,000 cu. ft. of water per minute when operating at 0.8 gate, and at a speed of 165 revolutions under a head of 34 ft. it will develop 5,092 HP., with an efficiency of 80%. At the same speed and with the same efficiency, each unit will develop 6,565 HP. Under the same conditions of head each of the exciter units will develop 632 HP. at a speed of 300 revolutions per minute. Each power unit consists of six 54-in. turbine water-wheels arranged on one shaft, with the necessary bearings, casings, gates and supporting frame work. Each wheel is provided with its own set of gates and all of

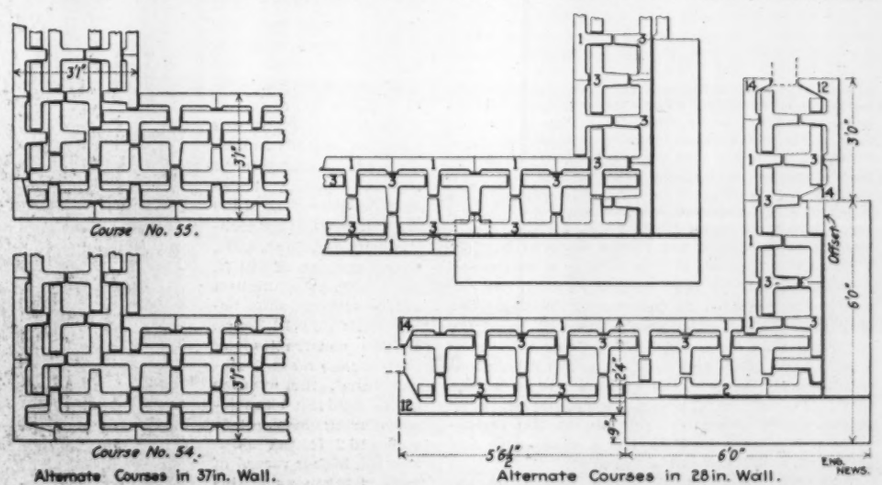


FIG. 7. SECTIONS OF WALLS OF POWER HOUSE; BUILT OF CONCRETE BLOCKS.

the gates in each unit will be controlled by one hydraulically operated governor. Running for the entire length of the water-wheel casing will be two 12-in. I-beams on either side of the draft tube openings. To these beams will be bolted cast-steel draft-tube collars extending about 6 ins. into the concrete. Resting on the draft tube collars will be the quarter-turns, made in two pieces, divided in a horizontal plane. There are six quarter turns, one for each wheel; the two at the ends deliver the water into individual draft tubes, while two each of the others deliver their water into one common draft tube, oblong in section. These two quarter-turns are bolted back to back and at the juncture there are formed bearings for the shafts. The bearings are fitted with bronze removable bushings, and with caps which can be removed to inspect the bearings. The bearings will be further enclosed in vertical tubes so that it will be possible to inspect them at any time. Each of the end quarter-turns has a bearing also cast in it, forming an integral part of the casting.

FIG. 8. CHANNELERS AND STEAM SHOVELS AT WORK ON THE TAIL RACE OF THE POWER PLANT.

The shaft for the wheels is divided into three parts coupled together, the couplings being located between the bearings. Each shaft carries two runners located near the center of the shaft. All of the shafts are made of uniform diameter, so that only a limited number of spare wheels need be carried in stock. The section of shaft which immediately connects to the generator is made of annealed nickel-steel. For lubricating the bearings of the power units there is provided a suitable pump and return tank so that each of the bearings will receive a continuous feed of oil.

Each of the turbines is fitted with a balanced gate of special design. The gates of each of two adjacent wheels are independently adjustable and are operated together from one gate ring. The gate rings will be moved through suitable connections by push and pull rods instead of by a rotating shaft, thereby insuring that the gates of the last wheel will move in unison with the gates of the first wheel and with the intermediate gates.

Each of the exciter units will consist of two 30-in. turbines discharging through a single draft tube in the penstock floor. The cases of each pair of these wheels are bolted to a cast-iron draft box having a suitable extension entering the concrete; the design of these casings presents no particularly new feature and is made in accordance with the usual practice for turbine construction.

The contract for four generators and two exciters was awarded to the Crocker-Wheeler Co., of Ampere, N. J. The generators will be of the revolving field type, 4,000 KW., 60 cycles, three-phase, 6,600 volts, and running at 165 revolutions per minute. Each of the exciters will be a 350-KW., 250-volt, multipolar, direct-current, compound-wound generator, running at 300 revolutions per minute, and having a shaft with two self-alining and self-oiling bearings.

TRANSMISSION LINE.—The length of the high-tension transmission line to Chicago will be about 30 miles, and it will be built on a private right of way from 200 ft. to ¼ mile in width. The poles will be spaced about 300 ft. apart and will have two cross-arms, 18 ft. 6 ins. and 12 ft long, with Locke three-part insulators. There will be four wires on the lower arm and two on the upper arm, the bottom wires being 47 ft. above the ground. There will be two circuits, and aluminum wires are to be used, equivalent to copper of No. 000 gage. The current will be generated at 6,600 volts at the power-house, stepped up to 44,000 volts for transmission, and delivered from the Chicago sub-station at 6,600 to 9,000 or 11,000 volts. Mr. E. B. Ellicott is electrical engineer.

HEAD RACE AND TAIL RACE WORK.—In the rock excavation of both the head race and tail race, the sides were formed by vertical cuts made by channeling machines, and the body of the rock between these cuts was drilled and blasted, the loose rock being removed by steam shovels and cars. Four Sullivan channelers were used, cutting a straight vertical face to a depth of 9 to 12 ft.; two cuts or "lifts" were required to secure the full depth of the head race and three lifts for the tail race. Fig. 8 shows the channelers and steam shovels at work on the second "lift" of the tail race.

Owing to the broken character of the rock, the channeling machines were fitted with Z-shaped solid steel bits instead of the five-piece gang-drills used in quarry work. Each machine has its own boiler, but on the head race work compressed air from a central compressor plant was sometimes used, while at the power house a steam fan or central boiler plant was used, as already noted. The one machine used at the power house made a record of 8,120 ft. during 40 consecutive shifts in June, 1905, or an average of 203 ft. per shift, the highest record for one shift being 382 ft. in 12 hours. In the construction of the Chicago main drainage canal, the average of 15 Sullivan channelers during May, 1905, was 116.2 ft. per shift, and the higher record of 1905 is taken as an indication of the improvement in the machines. All delays were taken into account in these records.

FIG. 9. CONCRETE MIXING AND ELEVATING MACHINE USED IN BUILDING THE CONCRETE WALLS OF THE HEAD RACE.

In building the high concrete walls of the head race, a special concrete mixing and elevating machine was used by Duffy Bros., the contractors, and a view of this is shown in Fig. 9. This view also shows the forms used and other details of the plant.

RECENT FIRE TESTS IN A THEATER MODEL IN VIENNA, AUSTRIA.

An interesting and highly valuable experimental study of the phenomena of theater fires was made a few weeks ago in Vienna, Austria, in a small-scale model theater erected specially for the purpose. The tests were made on the initiative of the Oesterreichische Ingenieur- und Architekten Verein; the support of the Theater Commission of Lower Austria, headed by Count Kielmannsegg, was secured, and through this the government was led to furnish means for the work. We abstract a brief account of the experiments from the "Zentralblatt der Bauverwaltung" of Dec. 20, 1905.

The model theater was built entirely of reinforced concrete. Its principal dimensions are as follows:

STAGE.—7.5 m. (24.6 ft.) wide, 6 m. (19.7 ft.) deep, 7.7 m. (25.3 ft.) high. A corridor space 1 m. (3.3 ft.) wide is cut off from the stage by a wall parallel to the proscenium wall and 1 m. back of it; this space has doors to the exterior at either end. The proscenium opening is 3.35 m. (11 ft.) wide and 2.6 m. (8.5 ft.) high. The roof of the stage pitches on all four sides rather steeply to a peak at the center.

AUDITORIUM.—5.5 m. (18 ft.) wide, 7 m. (23 ft.) deep, and 4.7 m. (15.4 ft.) high. Its roof is of rather flat pitch, with a level central ridge, running front to back. The floor pitches slightly downward toward the stage. The auditorium has a gallery running around the rear and both sides, about 7.4 ft. high above the floor. A door in the rear wall leading outward from this gallery connects with a stairway on the outside. Immediately below this is a similar door leading outward from the parquet. There is also a door to the exterior on each side wall of the auditorium, close to the proscenium wall. The rear portion of the parquet under the balcony is closed off by a transverse partition, glazed in the upper half, forming a room about 6 ft. deep and extending the full width of the auditorium.

The building is fitted with the following vent openings: A central vent in the peak of the stage roof, cross-section, about 6% of the stage area, or about 20 sq. ft. Four vents, one in each

corner of the stage room, each about 8.6 sq. ft. in cross-section; these corner vents extend down some distance below the roof by a hoodlike extension. The auditorium has a central vent in the middle of the ridge (size not stated).

A sprinkler system was fitted over the stage, controlled by a hand valve. The proscenium opening was fitted with a steel curtain and a fabric (asbestos?) curtain.

To simulate the scenery which occupies the stage of an actual theater, old scenes and rolls of paper, hung from wooden cross-strips, were suspended in the stage space to correspond to actual scenery. This material was not given any fire-resisting treatment*, but, on the contrary, was sprinkled with petroleum to make it more combustible. The amount of the material was such, in relation to the size of the stage, as to represent roughly the scenery corresponding to two performances.

The auditorium was fitted with various means of illumination to represent those which might be used in different theaters. There were gas lamps, candles, lard oil and petroleum lamps and electric incandescent lamps.

Five different tests were conducted in this model theater. After some preliminary experiment they were officially conducted on Nov. 22, 1905, in the presence of many interested individuals and authorities. The tests are briefly summarized as to arrangement and results in the following:

TEST I.—Fabric curtain down, stage vents closed, auditorium vents half open, all lamps in auditorium lighted. After the stage scenery was set afire the curtain bulged out toward the auditorium; continuing to bulge, it raised from the floor at the bottom, and a sheaf of flame was forced out of the opening. The auditorium was rapidly filled with smoke. The gas flames were soon extinguished by the increased air pressure; then, in succession, candles, oil and petroleum lamps went out, due to lack of sufficient oxygen, or were blown out by drafts. The electric lamps were wholly obscured by the smoke. The temperature in the auditorium rose to 400° C. (752° F.), and air pressures up to 6 ins. of water were observed.

TEST II.—Curtains raised, stage vents closed, auditorium vents half open, all lamps lighted; iron curtain lowered during fire. The lowering of the curtain successively decreased the area of communication between stage and auditorium and thereby forced the flames under considerable pressure into the auditorium. Otherwise results generally similar to those of Test I. In the preliminary tests it was observed that the iron curtain bulged as much as 4 mm. (0.16 in.), and amounts of carbon monoxide up to 8% were found in the air of the auditorium. It is to be noted that the curtain of this model is relatively stronger (very thin sheets not being at hand for its construction) than a steel curtain in a full-sized theater.

TEST III.—Curtains raised and remain so; stage vents closed, but are opened shortly after the fire is started; auditorium vents closed. The fire developed just as it would in a large fireplace, the smoke and gases passing out through the stage vents. The auditorium remained free of smoke, and there appeared to be no danger of injury to persons in the auditorium, except that near the proscenium opening the heat which was radiated from the stage was rather severe. The lights did not go out.

TEST IV.—The stage vents are opened after the fire is well under way, partly by the melting of fusible links, partly by hand; the iron curtain is lowered after the fire is set; auditorium vents are left closed. No danger of injury to persons in the auditorium resulted, and the lamps remained lighted.

TEST V.—Stage vents open; auditorium vents closed; curtains raised; after the fire has a good start the sprinklers are set in operation. A heavy spray of water poured down upon the stage when the sprinklers started, and the fire was materially checked. Smoke and steam escaped wholly through the stage vents and none entered the auditorium when the auditorium doors remained closed; but when any of the auditorium doors, especially the rear gallery door, was opened, a violent draft of hot air swept into the auditorium, carrying smoke, steam and burning fragments. The currents of hot air caused much discomfort and involved some danger to persons in the auditorium, but probably no very extensive danger because the temperatures were held down by the water. Smoke and gases escaped only from the peak vent of the stage, not from the corner vents.

The commission intends to publish a detailed report upon the tests in the near future.

*The Vienna regulations require all theater scenery to be fire-proofed.

REINFORCED CONCRETE FENCE POSTS.*

By Philip L. Wormeley, Jr.†

There is a constantly increasing demand for some form of fence post which is not subject to decay. The life of wooden posts is very limited, and the scarcity of suitable timber in many localities has made it imperative to find a substitute. A fence post, to prove thoroughly satisfactory, must fulfill three conditions: (1) It must be obtainable at a reasonable cost; (2) it must possess sufficient strength to meet the demands of general farm use; (3) it must not be subject to decay and must be able to withstand successfully the effects of water, frost and fire. Although iron posts of various designs are frequently used for ornamental purposes, their adoption for general farm use is prohibited by their excessive cost. Then, too, iron posts exposed to the weather are subject to corrosion, to prevent which necessitates repainting from time to time, and this item will entail considerable expense in cases where a large number of posts are to be used.

At the present time the material which seems most nearly to meet these requirements is reinforced concrete. The idea of constructing fence posts of concrete reinforced with iron or steel is by no means a new one, but on the contrary such posts have been experimented with for years, and a great number of patents have been issued covering many of the possible forms of reinforcement. It is frequently stated that a reinforced concrete post can be made and put in the ground for the same price as a wooden post. Of course this will depend in any locality upon the relative value of wood and the various materials which go to make up the concrete post, but in the great majority of cases, wood will prove the cheaper material in regard to first cost. On the other hand, a concrete post will last indefinitely, its strength increasing with age, whereas the wooden post must be replaced at short intervals, probably making it more expensive in the long run.

In regard to strength, it must be borne in mind that it is not practicable to make concrete fence posts as strong as wooden posts of the same size; but since wooden posts, as a rule, are many times stronger than is necessary, this difference in strength should not condemn the use of reinforced concrete for this purpose. Moreover, strength in many cases is of little importance, the fence being used only as a dividing line, and in such cases small concrete posts provide ample strength and present a very uniform and neat appearance. In any case, to enable concrete posts to withstand the loads they are called upon to carry, sufficient strength may be secured by means of reinforcement, and where great strength is required this may be obtained by using a larger post with a greater proportion of metal and well braced, as is usual in such cases. In point of durability, concrete is unsurpassed by any material of construction. It offers a perfect protection to the metal reinforcement and is not itself affected by exposure, so that a post constructed of concrete reinforced with steel will last indefinitely and require no attention in the way of repairs.

REINFORCEMENT.—No form of wooden reinforcement, either on the surface or within the post, can be recommended. If on the surface, the wood will soon decay, and if a wooden core is used it will in all probability swell by the absorption of moisture and crack the post. The use of galvanized wire is sometimes advocated, but if the post is properly constructed and a good concrete used, this precaution against rust will be unnecessary, since it has been fully demonstrated by repeated tests that concrete protects steel perfectly against rust. If plain, smooth wire or rods are used for reinforcement they should be bent over at the ends or looped to prevent slipping in the concrete. Twisted fence wire may usually be obtained at a reasonable cost and is very well suited for this purpose. Barbed wire has been proposed and is sometimes used, although the barbs make it extremely difficult to handle. For the sake of economy the smallest amount of metal consistent with the desired strength must be used, and this requirement makes it necessary to place the reinforcement near the surface, where its strength is utilized to greatest advantage, with only enough concrete on the outside to form a protective covering. A reinforcing member in each corner of the post is probably the most efficient arrangement.

CONCRETE FOR FENCE POSTS.—The concrete should be mixed with Portland cement in about the proportion 1-2½-5, broken stone or gravel under ½-in. being used. In cases where the aggregate contains pieces smaller than ¼-in., less sand may be used, and in some cases it may be omitted altogether. A mixture of medium consistency is recommended on the ground that it fills the molds better, and with less tamping than if mixed quite dry.

MOLDS FOR FENCE POSTS.—Economy points to the use of a tapering post, which, fortunately, offers no difficulties in the way of molding. All things considered wooden molds will be found most suitable. They can be easily and quickly made in any desired size and form. Posts may be molded either in a vertical or horizontal position, the latter being the simpler and better method. If molded vertically a wet mixture is necessary, requiring a longer time to set, with the consequent delay in removing the molds. Fig. 1 shows a simple mold, which has been used with satisfactory results in this laboratory. This mold has a capacity of four posts, but larger molds could easily be made on

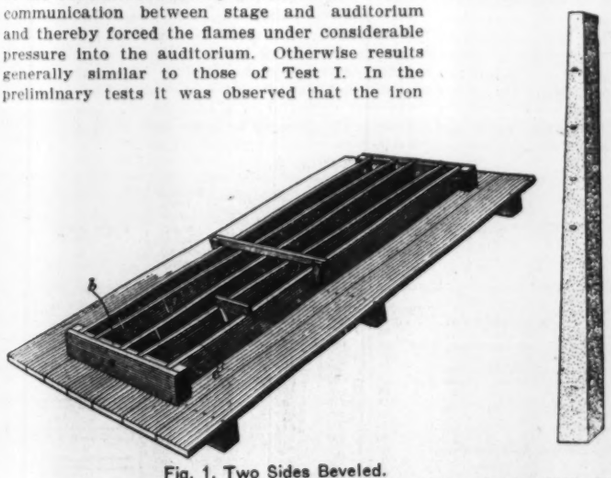


Fig. 1. Two Sides Beveled.

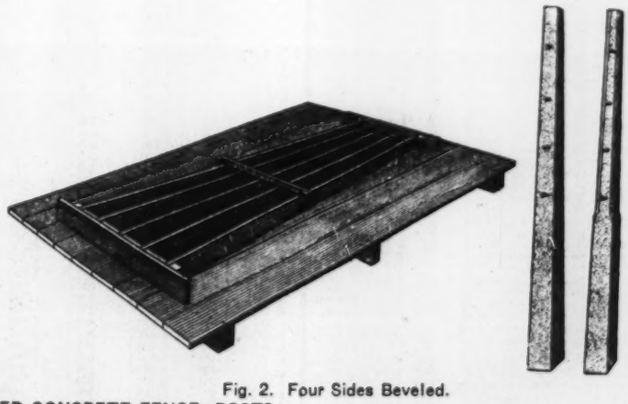


Fig. 2. Four Sides Beveled.

FIGS. 1 AND 2. MOLDS FOR REINFORCED CONCRETE FENCE POSTS.

*Extract from Farmers' Bulletin 235, U. S. Department of Agriculture.

†Testing Engineer, Office of Public Roads, Washington, D. C.

the same principle. It consists of two end pieces (a) carrying lugs (b) between which are inserted strips (c). The several parts are held together with hooks and eyes, as shown in Fig. 1. To prevent any bulging of the side strips they are braced, as illustrated. Dressed lumber at least 1 in. thick, and preferably 1½ ins., should be used. In Fig. 1 the post measures 6 × 6 ins. at the bottom, 6 × 3 ins. at the top, and 7 ft. in length, and has two parallel sides. If it is desired to have the posts square at both ends the mold must be arranged as in Fig. 2. This latter form of post is not as strong as the former, but it requires less concrete in its construction. Great care in tamping is necessary to insure the corners of the mold being well filled, and if this detail is not carefully watched, the metal, being exposed in places, will be subject to rust.

Fig. 3. Sketch Showing Attachment of Wire to Reinforced Concrete Post.

ATTACHING FENCE WIRES TO POSTS.—Various devices have been suggested for attaching fence wires to the posts, the object of each being to secure a simple and permanent fastener or one admitting of easy renewal at any time. Probably nothing will answer the purpose better than a long staple or bent wire well embedded in the concrete, being twisted or bent at the end to prevent extraction. Galvanized metal must be used for fasteners since they are not protected by the concrete. A piece of small flexible wire, about 2 ins. in length, threading the staple and twisted several times with a pair of pliers, holds the line wire in position (Fig. 3).

MOLDING AND CURING POSTS.—It is recommended that only so much concrete be mixed at one time as can be used before it begins to harden; but if an unavoidable delay prevents the posts being molded until after the concrete has begun to set, it is thought that a thorough regaging with sufficient water to restore normal consistency will prevent any appreciable loss of strength, though the concrete may have been standing one or two hours. In using a mold similar to those illustrated in Figs. 1 and 2 it is necessary to provide a perfectly smooth and even platform of a size depending upon the number of posts to be molded. A cement floor if accessible may be used to advantage. The molds when in place are given a thin coating of soft soap, the platform or cement floor serving as bottom of mold being treated in the same way. About 1½ ins. of concrete is spread evenly over the bottom and carefully tamped, so as to reduce it to a thickness of about 1 in. A piece of board cut as in Fig. 1 will be found useful in leveling off the concrete to the desired thickness before tamping. On top of this layer two reinforcing members are placed about 1 in. from the sides of the mold. The molds are then filled and tamped in thin layers to the level of the other two reinforcing members, the fasteners for fence wires being inserted during the operation. These reinforcing members are adjusted as were the first two, and the remaining 1 in. of concrete tamped and leveled off, thus completing the post so far as molding is concerned. To avoid sharp edges which are easily chipped triangular strips may be placed in the bottom of mold along the sides, and when the molds have been filled and tamped, similar strips may be inserted on top. The top edges may be beveled with a trowel or by running an edging tool having a triangular projection on its bottom along the edges. Such a tool is shown in Fig. 4 and can easily be made of wood or metal. It is not necessary to carry the bevel below the ground line.

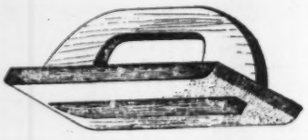


Fig. 4. Tool for Beveling Corners of Posts.

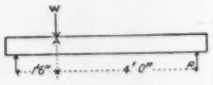


Fig. 5.

The end and sides of the mold may be removed after 24 hours, but the posts should not be handled for at least one week, during which time they must be well sprinkled several times daily and protected from sun and wind. The intermediate strips may be carefully withdrawn at the end of two or three days, but it is better to leave them in place until the posts are moved. Although a post may be hard and apparently strong when one week old, it will not attain its full strength in that length of time and must be handled with the utmost care to prevent injury. Careless handling green posts frequently results in the formation of fine cracks, which, though unnoticed at the time, give evidence of their presence later in the failure of the post.

Posts should be allowed to cure for at least 60 days before being placed in the ground, and for this purpose it is recommended that when moved from the molding platform they be placed upon a smooth bed of moist earth and protected from the sun until thoroughly cured. During this period they should receive a thorough drenching at least once a day.

The life of the molds will depend upon the care with which they are handled. A coating of mineral oil or shellac may be used instead of soap to prevent the cement from sticking to the forms. As soon as the molds are removed they should be cleaned with a wire brush before being used again.

The cost of reinforced concrete fence posts depends in each case upon the cost of labor and materials, and must necessarily vary in different localities. An estimate in any particular case can be made as follows. One cu. yd. of concrete will make 20 posts measuring 6 ins. × 6 ins. at bottom, 6 ins. × 3 ins. at top, and 7 ft. long, and if mixed in the proportions 1-2½-5, requires approximately:

1.16 barrels of cement, at $2	$2.32
0.44 cu. yd. of sand, at 75 cts.	.33
0.88 cu. yd. of gravel, at 75 cts.	.66
Materials for 1 cu. yd. concrete	3.31
Concrete for one post	.17
28 ft. of 0.16-in. steel wire, at 3 cts. per lb	.06
Total cost of concrete and metal for one post	.23

To this must be added the cost of mixing concrete, molding and handling posts, and the cost of molds, an addition which should not in any case exceed 7 cts., making a total of 30 cts. per post.

TESTS OF CONCRETE FENCE POSTS.—In the summer of 1904 a number of reinforced concrete fence posts were made for experimental purposes, with a view to determining their adaptability for general use. These posts were made both with and without reinforcement, and tested at the age of 90 days. The reinforcement, ranging from 0.27% to 1.13%, consisted of four round steel rods, one in each corner of post about 1 in. from the surface, the posts having a uniform cross-section of 6 × 6 ins. The posts were molded in a horizontal position, as this was found by trial to be more satisfactory than molding them vertically.

The concrete was mixed moderately soft, crushed stone between 1 in. and ¼-in. and gravel under ¾-in. being used as aggregate. River sand, fairly clean and sharp, was employed with Portland cement. The posts were tested as beams supported at both ends and loaded at the center, with spans varying from 4 ft. to 5 ft. 6 ins. An attempt was made to prevent slipping by providing the reinforcing rods with collars and set screws at the ends, but in every case, with but two exceptions, the rods slipped under a comparatively light load, thus showing the necessity for some form of mechanical bond.

TABLE I.

No.	Kind of reinforcement.	Per cent of reinforcement.	Mixture.	Material.	Span.	Load at first crack.	Maximum load.	Equivalent load on 4-foot cantilever at first crack.	Equivalent maximum load on 4-foot cantilever.
					Ft. in.	Pounds.	Pounds.	Pounds.	Pounds.
1	No reinforcement.	.....	1-3-5	Stone	4 0	1,435	1,435	359	359
2	do	.....	1-3-5	do	4 0	670	670	168	168
20	do	.....	1-3-7	Gravel	4 6	700	700	196	196
25	do	.....	1-3-5	do	4 6	320	320	90	90
26	do	.....	1-2-5	do	4 0	1,100	1,100	275	275
30	do	.....	1-2-5	do	4 0	1,000	1,000	250	250
4	Plain steel rods	0.27	1-3-5	Stone	4 0	1,580	1,850	395	463
17	do	.27	1-3-5	do	4 0	1,135	1,945	284	486
21	do	.27	1-3-5	do	4 6	920	1,680	258	473
24	do	.27	1-3-5	do	4 6	940	1,660	263	465
28	do	.27	1-3-5	do	4 6	800	1,720	224	482
36	do	.27	1-2-5	Gravel	4 0	1,100	1,550	275	388
29	do	.27	1-2-5	do	4 6	900	1,480	252	409
39	do	.27	1-2-5	do	4 0	1,340	1,640	335	410
40	do	.27	1-2-5	do	5 6	760	1,120	258	381
42	do	.27	1-2-5	do	4 6	1,100	1,290	308	361
44	do	.27	1-2-5	do	5 6		1,060		367
3	do	.52	1-3-5	Stone	4 0	1,800	2,580	450	638
7	do	.52	1-3-5	do	4 6	1,600	2,155	448	603
13	do	.52	1-3-5	do	4 0	1,640	2,500	410	625
15	do	.52	1-3-5	do	4 0	1,960	2,400	490	600
27	do	.52	1-3-5	do	4 0	1,680	2,220	420	555
45	do	.52	1-2-5	Gravel	5 6	920	1,800	313	613
46	do	.52	1-2-5	do	4 0	900	2,740	225	685
47	do	.52	1-2-5	do	4 6	1,000	2,450	280	686
50	do	.52	1-2-5	do	4 0	1,200	3,125	300	781
5	do	.81	1-3-5	Stone	4 0	2,640	4,800	660	1,200
10	do	.81	1-3-5	do	4 0	1,480	4,100	370	1,025
12	do	.81	1-3-5	do	4 6	1,880	4,100	521	1,148
14	do	.81	1-3-5	do	4 6	1,800	3,915	504	1,096
19	do	.81	1-3-5	do	4 0	1,800	4,160	450	1,040
22	do	.81	1-3-5	do	4 6	1,900	2,900	532	812
34	do	.81	1-2-5	Gravel	4 6	1,750	4,100	490	1,148
37	do	.81	1-2-5	do	4 0	1,800	3,845	375	802
43	do	.81	1-2-5	do	4 0	1,700	4,200	425	1,050
48	do	.81	1-2-5	do	4 6	1,240	3,575	347	1,001
6	do	.95	1-3-5	Stone	4 0	1,480	5,150	495	1,288
11	do	.95	1-3-5	do	4 6	2,380	4,300	666	1,204
18	do	.95	1-3-5	do	4 6	1,800	4,240	504	1,187
49	do	.95	1-2-5	Gravel	5 6	900	2,600	308	894
51	do	.95	1-2-5	do	4 6	1,380	3,160	386	885
52	do	.95	1-2-5	do	4 6	1,200	3,345	336	937
53	do	.95	1-2-5	do	4 0	1,340	3,340	335	960
54	do	.95	1-2-5	do	5 6	980	2,600	353	884
8	do	1.13	1-3-5	Stone	4 6	2,220	3,880	622	1,070
9	do	1.13	1-3-5	do	4 0	2,580	5,080	640	1,270
16	do	1.13	1-3-5	do	4 6	2,000	3,100	560	868
23	do	1.13	1-3-5	do	4 0	1,800	4,900	450	1,225
29	do	1.13	1-3-5	do	4 0	2,400	4,460	600	1,115
32	do	1.13	1-2-5	Gravel	4 6	1,500	2,900	420	812
33	do	1.13	1-2-5	do	4 0	1,400	2,280	350	580
38	do	1.13	1-2-5	do	4 6	1,500	3,270	420	916
41	do	1.13	1-2-5	do	4 6	1,250	4,300	350	1,204
55	Pipe 5 inches diameter, ⅛-inch thick.	1.10	1-2-5	do	4 6	1,800	4,000	504	1,120
56	do	1.10	1-2-5	do	4 6	1,720	4,000	482	1,120
57	do	1.10	1-2-5	do	4 6		4,660		1,305
58	□ 5 by 5 inches, ⅛-inch thick.	1.39	1-2-5	do	4 6	2,400	6,320	672	1,770
59	do	1.39	1-2-5	do	4 6	2,100	5,880	588	1,646
60	do	1.39	1-2-5	do	4 6	2,200	6,040	616	1,691
61	× 5 by 5 inches, ⅛-inch thick.	.98	1-2-5	Stone	4 6	1,100	2,450	308	686
62	do	.98	1-3-5	do	4 6	860	2,660	241	745
63	do	.98	1-3-5	do	4 6	1,800	2,400	504	672

TABLE II.

No.	Kind of reinforcement.	Total sectional area of reinforcement.	Load at first crack.	Maximum load.	Equivalent load on 4-foot cantilever at first crack.	Equivalent maximum load on 4-foot cantilever.	Form of reinforcement.
		Sq. in.	Lbs.	Lbs.	Lbs.	Lbs.	
1	Drawn steel rods	0.08	800	1,120	218	306	
2	do	.08	820	1,145	224	313	
3	do	.08	640	1,060	175	295	
4	do	.08	795	1,040	217	284	
37	do	.08	940	1,170	257	319	
38	do	.08	740	1,075	202	293	
9	do	.19	1,140	1,280	311	349	
10	do	.19	1,170	1,895	319	515	
11	do	.19	1,020	1,950	278	532	
39	do	.19	780	1,945	207	531	
40	do	.19	820	1,925	224	526	
13	Twisted fence wire	.08	825	925	225	252	
15	do	.08	755	905	206	247	
16	do	.08	800	940	218	257	
17	do	.08	815	965	222	265	
18	do	.08	770	960	210	262	
19	do	.08	780	975	213	266	
21	do	.13	1,550	1,920	423	524	
22	do	.13	1,275	1,670	348	456	
23	do	.13	1,200	1,830	328	500	
24	do	.13	1,500	1,955	410	534	
35	Barbed wire	.08	980	980	268	268	
26	do	.08	820	820	224	224	
27	do	.08	590	740	161	202	
28	do	.08	745	745	203	203	
29	do	.08	590	590	161	161	
30	do	.08	560	640	150	175	
31	do	.08	580	625	153	170	
32	do	.08	480	530	131	145	
33	do	.13	680	1,040	186	284	
34	do	.13	840	1,010	229	276	
35	do	.13	1,280	1,515	349	414	
36	do	.13	800	1,375	218	375	
6	Drawn steel rods	.08	Tested by impact				
7	do	.19	do				
8	do	.19	do				
14	Twisted fence wire	.08	do				
20	do	.08	do				

As would be expected, those posts which were not reinforced possessed very little strength.

A series of tests were made with sheet-iron reinforcement in the form of round and square pipes, embedded in the posts, but these posts, though developing considerable strength, proved less economical than those reinforced with plain rods, and at the same time were less simple in construction. The results of these tests, as recorded in Table I., do not properly represent the strength of similar posts in which some form of mechanical bond is provided to develop the full strength of the reinforcement.

In order to obtain more data on the subject, this investigation has been supplemented by a second series of tests, the results of which form the subject-matter for

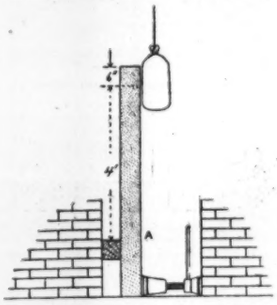


Fig. 6.

the sections on concrete fence posts and are expressed numerically in Table II.

In these tests it was decided to make the posts tapering in order to economize material and reduce their weight. For the concrete, Portland cement, river sand and gravel were used in the proportion 1-2½-5, measured by volume, the gravel being screened below ½-in. Sufficient water was used in mixing to produce a plastic mass, requiring only a moderate degree of tamping to bring water to the surface. The posts were molded, as described, kept under wet burlap for four weeks, and tested at the end of 60 days. The reinforcing members were placed in the corners of the posts about 1 in. from the surface, being looped and bent, as indicated in Table II. These posts were not designed with a view to developing the ultimate compressive strength of the concrete, but where greater strength is necessary it may be obtained at small expense by increasing the percentage of reinforcement. It is important that a fairly rich concrete should be used in all cases to enable the posts to stand exposure and to prevent chipping.

In these tests, as in those previously described, the object was to determine what transverse load, applied at a point 4 ft. above the ground line, would be sufficient to crack the post, as well as the maximum load which could be sustained. Accordingly the posts were supported and loaded, as illustrated in Fig. 5, from which it is evident that the reaction at R represents the equivalent transverse load at the end of a 4-ft. cantilever, corresponding to the applied load W at A, which is supposed to be the ground line, near which point failure occurred in every case except post No. 9, which sheared along the neutral axis. All of these posts measured 6 x 6 ins. at the bottom and 6 x 3 ins. at the top, except six, which were 6 x 6 ins. at the bottom and 3 x 3 ins. at the top. It will be noticed that the saving in concrete introduced in the construction of these posts is accompanied by a marked decrease in strength as compared with the other posts similarly reinforced. It would also appear that the twisted wire has a slight advantage over the barbed wire as a reinforcing material, particularly when two wires are used in each corner of the post.

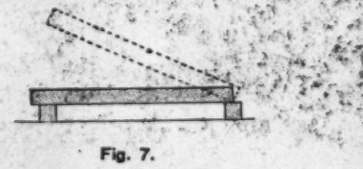


Fig. 7.

It is impracticable to make a reinforced concrete fence post as strong as a wooden post of the same size, and this is more especially true if the post has to withstand the force of a sudden blow or impact. In order to study the behavior of these posts under impact, a number of them were braced, as illustrated in Fig. 6, and subjected to the blows of a 50-lb. bag of gravel, suspended from above by a 9-ft. rope. The first blow was delivered by deflecting the bag so as to give it a vertical drop of 1 ft., and for each successive blow the drop was increased 1 ft. None of the posts showed any signs of failure under the first blow. Posts Nos. 14 and 20 cracked under the second blow, and failed under the third. Post No. 6 cracked under the second blow, which crack opened under the third blow, causing a momentary deflection of 5 ins. Posts Nos. 7 and 8 each developed a crack under the second blow, but showed no further signs of weakness after the fifth blow, other than a slight opening of the initial crack. In each case the only crack developed was at point A. Posts 6, 7 and 8, which cracked but did not fail under the impact test, were further tested, as indicated in Fig. 7, by raising the small end and allowing them to drop from successive heights at 1, 2, 3 and 4 ft. Under this test a number of cracks developed, but in no case did the reinforcement fail.

Although it might appear from these results that posts as here described have hardly enough strength to recommend them for general use, it should be remembered that in many cases fence posts are not subjected to impact, and it may prove more economical to replace from time to time those which fail in this way than to use wooden posts, which, being subject to decay, must all be replaced sooner or later.

SINGLE-PHASE ELECTRIC TRACTION EQUIPMENT OF THE ST. CLAIR TUNNEL, GRAND TRUNK RY.

In 1890, eleven years after the Grand Trunk system became international by the consolidation of the Grand Trunk Ry. and the Chicago & Grand Trunk Ry., the system was physically joined at the international boundary by a railway tunnel under the St. Clair River, between Port Huron, Michigan, and Sarnia, Ontario. This tunnel displaced a car-ferry which was previously operated across the river at a point a few miles north. Since that time the tunnel and its approach grades on either side have been operated as a separate division, equipped with specially heavy engines to handle trains on the 2% grades at each end of the tunnel.

At the present moment a contract is being carried out for replacing the steam locomotives on the tunnel division by electric locomotives, to relieve traffic congestion and especially to do away with the annoying and dangerous smoke and gases in the tunnel. The change is notable as an improvement of traffic conditions at this point, but is of considerably wider interest in the character of its equipment—first, because it adds an important tunnel to the brief list of electrically operated tunnels on main line railways; second, because it introduces heavy single-phase alternating-current locomotives in their first commercial use and in a short-distance service which is of the very class hitherto considered the special field of direct-current traction.

The St. Clair Tunnel Co., owner of the tunnel, is having the work done. Mr. Bion J. Arnold, of Chicago, Ill., is Consulting Engineer of the work, and the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa., is the Contractor for the entire installation. Mr. Arnold and the contracting company have given us a general description of the work, from which the following article is compiled:

The small map Fig. 1* shows the immediate neighborhood of the tunnel, and will serve to fix in the mind the general problem involved in the present electric equipment. The St. Clair River, which is a link in the Great Lakes chain, and drains Lake Huron to Lake Erie, is about 2,200 ft. wide at the location of the tunnel. The tunnel itself is a trifle over a mile long between portals (6,032 ft.), and at its deepest point its floor is 78 ft. below the water surface of the river. From this point, which lies directly under the river bank on the Sarnia (east) side, a 2% grade, 5,184 ft. long, rises eastward to the surface; westward, the bottom "level" rises on a 0.1% grade for 1,718 ft., where begins the 2% Port Huron grade, 4,914 ft. long. Just beyond the top of grade on either side the line tracks fan out into a yard stretching along over half a mile (the distance from summit of grade to yard limit is 3,583 ft. on the Port Huron side, 3,949 ft. on the Sarnia side). This stretch between yard limits is the line to be operated by electric locomotives; the total length of electric division is thus 19,348 ft.

The tunnel itself has but a single track. Double track begins at points two or three hundred feet out from the portals; the total length of single track is close to 7,000 ft. As but one train can occupy this single-track section, the train capacity of the tunnel division is ultimately limited by the celerity with which trains can be got over this 7,000-ft. section. At present the tunnel division is frequently congested, and the electric installation has as one of its two purposes the elimination of such congestion. To provide for present as well as future traffic, the equipment was desired to be such as would offer the maximum train capacity, other things being equal. This desideratum actually had bearing on the decision for the particular type of equipment contracted for.

At the present time trains arriving at the tunnel division yards on either side are split up, when necessary, into trains of five or six hundred tons or less for passage through the tunnel. The resulting delay is at all times of moment, but becomes serious in times of heavy traffic; the tunnel division is then overtaxed and traffic becomes congested. The depth of the tunnel and the large volumes of smoke emitted by the high-powered tunnel locomotives make it frequently difficult to keep the air in the tunnel sufficiently clear for the operation of trains. Numerous accidents have occurred in the past 15 years, where train crews were rendered unconscious by the poisoning gases and trains were stalled.

It has been realized by the railway company for some years past that means for relieving these conditions were urgently needed, more especially so as larger train loads became common and the tunnel service required ever larger locomotives, involving more concentrated production of smoke. The substitution of electric locomotives for the steam tunnel locomotives to haul trains through the tunnel was clearly suggested. The desirability of employing locomotives of high power, to remove the existing possibility for congestion, doubtless gave the question a more complex aspect, in spite of the successful employment of very heavy electric locomotives in the Baltimore tunnel of the Baltimore & Ohio Ry. The advancing technic of electric traction appears to have brought encouragement, however, so that about two years ago the railway company called for competitive bids for complete electric equipment to operate the St. Clair tunnel. This was the first of three steps toward the work now under way.

The problem presented by the St. Clair tunnel, considered as an electric traction and a power-supply scheme, possesses several peculiar features which essentially characterize it. Primarily it is a very short line, as electric traction and distribution systems go. The extreme length is something less than four miles, and the source of power, presumably to be located on the river bank, is at the middle point. Thus, high-tension distribution of current is not an imposed condition, and a direct-current system without rotary converters may be considered; in fact, this is the conventional solution. A second condition is the great variability of the load; in other words, the low "load factor" of the line. The system can never have more than one train working at high duty (climbing the 2% tunnel grade), and even this can occupy only about one-half the time of transit through the tunnel. The load on the power station will thus consist of a period of maximum load (especially when one train is just starting out of the yards at the same time an opposing train is on the grade), followed by a period of virtually zero load, each of these periods being six to eight minutes long. Such variation of load, equally troublesome in the engine room and at the coal pile, seems to offer ideal conditions for a storage battery installation as equalizer.

A third condition affecting the problem is the existence of a lighting and motor (power) load and a very variable pumping load of rather large maximum. The tunnel approaches required, of course, constant, though inconsiderable, pumping to drain them; during rains it requires a pumping plant of large capacity to handle the water as fast as it is brought in by the long approach grades. At each end of the tunnel there is at present a steam pumping plant of very respectable size, which operates at full power only

*Reproduced from an article in Engineering News of Oct. 4, 1890, the first of an extended series of articles in which the construction of the St. Clair tunnel was very fully described.

occasionally, but requires constant attendance. With electric traction equipment the pumping would naturally be done by electrically driven pumps, and the electric scheme must consider this factor in its design. The pumpage requirements are indicated by the list of machines included in the electric contract to perform the

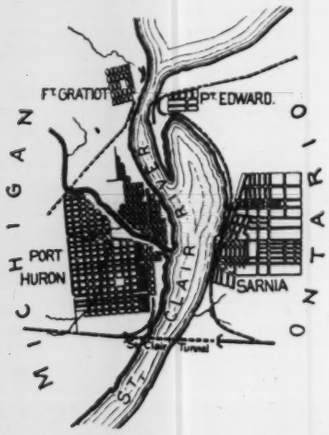


Fig. 1. Map of St. Clair Tunnel of the Grand Trunk Ry.

pumping service. These represent a water horsepower over 400 HP., and at an average efficiency (motor and pump combined) of 55%, an electric load of about 750 HP. or 550 KW.

The load diagram, Fig. 2, represents the typical curve of power demand on the division when maximum lighting and pumping load is on, after a diagram drawn up by the consulting engineer for the information of bidders, as noted further below. The locomotive load, it should be noted, is computed for a 1,000-ton train running at a minimum speed of 10 miles per hour on the 2% upgrade. When the lighting and pumping load is off the line the curve is still more fluctuating, evidently, than that shown. This load curve, taken in connection with the distance of transmission in the problem, quite fully represents the technical conditions which confronted bidders. It is proper to say that at the time the first bids for equipment were received these conditions were by no means so definitely outlined.

To return to a chronological account: after receiving general designs and bids for equipment from several different electric companies, covering direct-current and single-phase alternating equipment, the railway officials commissioned Mr. Bion J. Arnold, of Chicago, Ill., to study the problem and report upon it and upon the bids. This study began with the conviction that the proposition of electric traction in the St. Clair tunnel was feasible and advisable, and proceeded with an analysis of the technical and the cost phases of the matter. Thus, the important factor of reliability, or security against interruption of service, was given due consideration, as was also the speed factor; that is, the importance of developing the maximum train capacity of the tunnel by running trains through in the shortest average time. Essentially, the study was a comparison of (1) direct-current working, both with and without storage battery equalization, at standard voltage (about 600 volts), with (2) single-phase alternating-current working, at high voltage (2,000 to 3,000 volts), also with and without storage battery (using transformers and motor-generators in the latter case). For such a comparison Mr. Arnold's long connection with direct-current traction work and his original work in the single-phase field gave him special qualifications.

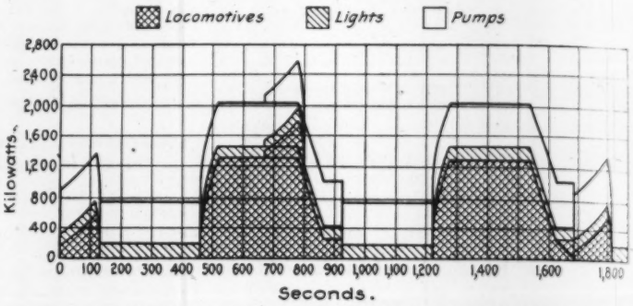


FIG. 2. LOAD-CURVE OF ST. CLAIR TUNNEL DIVISION UNDERMAXIMUM SERVICE WITH 1,000-TON TRAINS, AND MAXIMUM LIGHTING, PUMPING AND AUXILIARY LOAD.

The rather surprising result developed that, financially, the straight single-phase alternating-current equipment had slightly the better of the cost comparison. The differences of cost (both first cost and running expense) were, however, relatively so small that other factors were left to dictate the decision. These factors were (1) the well-established status of direct-current traction equipment, as against the less perfect development of single-phase motors and controllers; (2) the added reliability secured by a storage battery; (3) the differences in the speed characteristics of direct-current motors and single-phase motors; (4) the added risk of the higher voltage with the alternating current; (5) the possible objections to the third-rail network of the direct-current equipment. With regard to the last-named factor, it must be noted that the high maximum power-demand of the traction service—1,800 KW.—would, at 600 volts, the standard direct-current voltage, require a current of 3,000 amperes in the track conductor. Such a current calls for conductors of such size and weight that overhead construction would be of virtally prohibitory expense. In other words, direct-current equipment of the usual kind necessarily required third-rail current supply. The officials of the company appear to have entertained mark[illegible] objection to a third-rail network.

Following the study above mentioned, Mr. Arnold was directed to prepare general pla[illegible] and specifications for both direct and alternati[illegible] current equipment, proportioned to the servic[illegible] contemplated, upon which bidders could subm[illegible] bids as a basis for contract. These final bids, submitted some months ago, did not, it appear, reduce the advantage in cost which Mr. Arnold had deduced for the alternating-current system. A decision was finally made in favor of a [illegible]-cycle, 3,300 volt alternating-current single-phase equipment on the bid of the Westinghouse Electric & Mfg. Co., to whom the contract has been recently awarded. The deciding factors were: first, the fact that the alternating-current system, with high trolley voltage, permitted overhead construction as against the third-rail of the direct-current; second, the greater speed range of the alternating-current motors, which will permit better speed with light trains; third, the lower first cost. The coal cost of the alternating-current equipment will, on the performance curves submitted by the bidders, be somewhat lower than that of an equivalent direct-current installation. It appears that the reliability value of a storage battery has for the present been considered insufficient to justify the added expense of a storage battery.

In the plant as designed and contracted for matters of special interest are found in each of the three essential parts—power station, conducting system, and locomotives. (1) The power-generating equipment is required to supply three-phase current for the pumping machinery (and a few roundhouse motors and the lighting), and single-phase current for trains; the bulk of the output will go out as single-phase at the times of heavy load (see Fig. 2), but in the intervals when

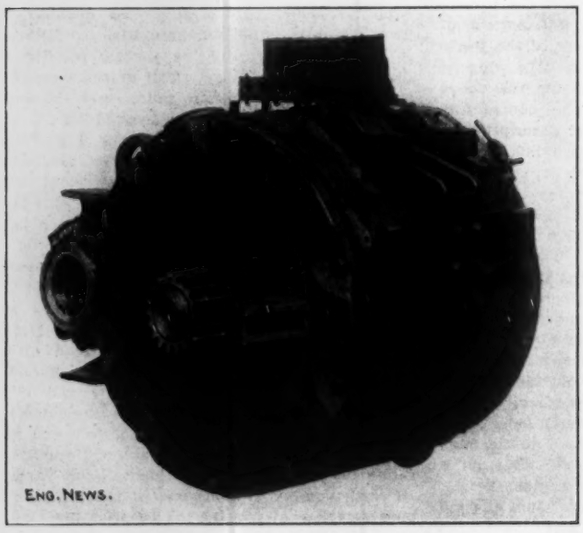


FIG. 3. VIEW OF 250-HP. SINGLE-PHASE ALTERNATING CURRENT RAILWAY MOTOR.

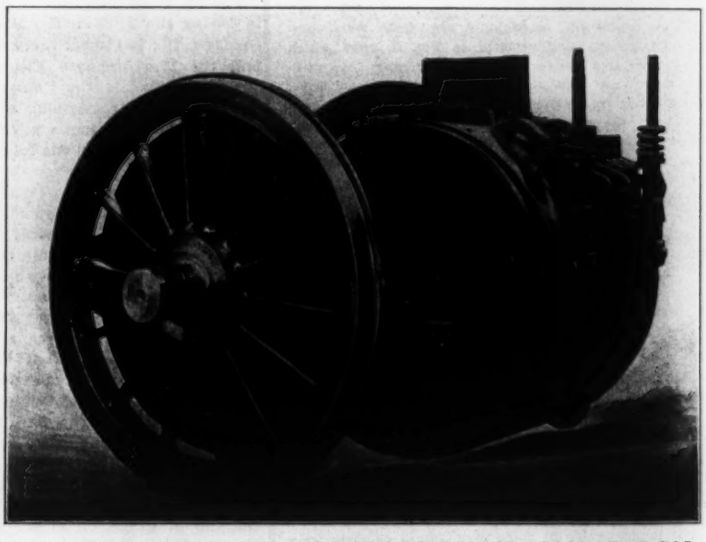


FIG. 4. MOTOR AND DRIVING AXLE OF SINGLE-PHASE LOCOMOTIVE FOR ST. CLAIR TUNNEL.
Diameter of Driver, 62 Ins.

the trains draw no power the load will be three-phase load, with substantially balanced phases. This unusual requirement will be fully met under the contract. (2) The conducting system is subject to the restrictions of very small clearance in the tunnel, while outside it should be of normal construction; it is subject to the high voltage of 3,000 to 3,300 volts; inside the tunnel it has to contend with moisture, and outside it must be adaptable to the yard layout, where there are at some points nearly a dozen tracks side by side

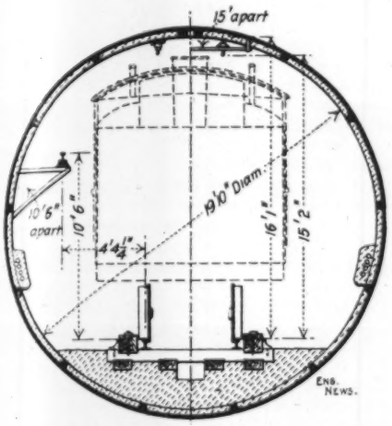


Fig. 5. Cross-Section of St. Clair Tunnel, Showing Overhead Construction and Side-Rail Construction for 3,000-Volt Single-Phase Traction.

The overhead trolley-wire construction shown at the left of the center line is that indicated in the specifications of the Consulting Engineer. The side-rail construction shown at the left is that offered by the Contractor. The overhead trolley-wire construction shown at the right is an alternative solution offered by the Contractor.

to be equipped. A messenger-wire or "single catenary" construction on transverse towers is employed outside the tunnel. For the tunnel conductor two designs are under consideration, either of which should meet the needs of the case. (3) Finally, the locomotives are notable, as stated at the opening of this article, because they are the first heavy units employing the recently developed series single-phase motor. The locomotives, being the basal part of the installation, will be described first.

62-TON SINGLE-PHASE LOCOMOTIVES.

The general specification prepared by the Consulting Engineer fixed the construction of the locomotives quite closely and defined the exact service which would be required. Three locomotives were called for, each to be capable of hauling a 1,000-ton train from summit to summit in 15 mins., with a speed not greater than 25 miles per hour on the down grade and not less than 10 miles per hour on the up grade; to perform this service continuously with no temperature rise in any part greater than 85° C. above the surrounding air; to be capable of exerting a drawbar pull of 50,000 lbs. for 5 mins.; to be capable of starting a 1,000-ton train from rest on the 2% grade and hauling it over the summit. The locomotive should weigh not less than 100 tons or more than 140 tons, all to be on drivers, but no driving axle to have a greater load than 50,000 lbs. The specified clearances were 13 ft. 6 ins. in height and 11 ft. in width. The clearance between motor frame and back of wheel flange was to be not less than 1¼ ins., and the clearance of motor above top of rail was to be not less than 6 ins. in the lowest position of the motor with new tires. The control system was to be such that two or more locomotives coupled together could be operated from the cab of either one, and in all cases by similar movements of controlling handles irrespective of the position of the locomotives.

Omitting more detailed quoting from the specifications, we take up a description of the locomotives as they will be furnished. It will appear that two of these units represent one locomotive as referred to above, which arrangement was expressly permitted in the specifications.

Six locomotives (corresponding to the three above called for) will be furnished by the contractor. Each will weigh approximately 62 tons, and will develop a draw-bar pull of 25,000 lbs. on a 2% grade at a speed of 10 miles per hour. It is of the rigid frame type, with driving axle boxes held in the same frame that contains the draft gear. It will be mounted on three pairs of driving wheels, which will sustain the entire weight, distributed by equalizer bars similar to those used in steam locomotive practice, will have an outside frame supported on semi-elliptical springs, and will be equipped with Westinghouse friction draft gear, M. C. B. automatic couplers, air sanding apparatus, etc. The cab will be of sheet steel mounted on a framework of iron. The principal dimensions will be approximately as follows:

Length over end sills	27 ft. 9 ins.
Rigid wheel base	12 ft.
Width over all	9 ft. 6 ins.
Height from top of rail to top of cab	12 ft. 6 ins.
Diameter of driving wheels	62 ins.

The operating apparatus will be arranged along the sides of the cab, leaving a free passageway 3½ ft. wide the entire length. The cab will be lighted and heated by electricity. Westinghouse combination automatic and straight air and American driver brakes will be used. The air supply will be provided by a two-cylinder, motor-driven air compressor of a capacity of 45 cu. ft. of air per min.

A motor rated at 250 HP. will be geared to each axle, giving each unit an aggregate rated capacity of 750 HP. The motors are of the Westinghouse single-phase, alternating-current, series-wound, compensating type. Each will weigh complete approximately 14,500 lbs., the armature weighing approximately 5,600 lbs.

The locomotive will take current from an overhead conductor at 3,000 volts, 25 cycles. An auto-transformer on the locomotive reduces the voltage to 240, which is the pressure on the motors.

The motor frame consists of a steel cylinder, cast in one piece and enclosed at the end by brackets of the same material, which carry the bearings and oil reservoirs. Seats for the axle bearings are cast solid with the frame. All bearings are of phosphor-bronze, lined with babbitt, and are divided into two parts. They are arranged for oil waste lubrication, and are provided with large openings on the low pressure side, giving a thorough lubrication of the entire bearing surface. Oil is fed into the reservoirs through openings separate from the waste pockets and therefore reaches the waste from below and is thoroughly filtered before entering the bearing.

The motors are swung between the locomotive frame and the driving axles by a flexible nose suspension from two hangers, supported by a truck transom, and passing through heavy lugs with helical springs above and below the lug. The motors are held to the axle by means of caps, which are split at an angle of 35% with the perpendicular, so that the greater part of the weight is borne by solid projections from the motor frame, which extend over the axle, rather than by the cap bolts. Large openings above and below provide access to the commutator and brush holders.

Within the cylinder of the motor frame there is built up a core of soft steel punchings, forming a completely laminated field. The punchings are dovetailed into the frame and clamped between end rings of cast steel. The field coils are wound with copper strap, insulated between turns and about the coils by mica and finished by taping and dipping. In addition to the main coils the field carries a neutralizing winding, which consists of copper bars placed in slots in the pole faces and joined at the ends by connectors of copper strap, so as to form one continuous winding, which is connected in series with the main field winding and with the armature circuit. The magnetizing effect of this auxiliary winding is directly opposite to and neutralizes that of the armature winding, thus eliminating the effect of armature reaction and improving commutation and power factor. The main coils can be easily removed without disturbing the auxiliary winding.

The armature is formed of slotted soft steel punchings built up on a spider and keyed in place. Coils of copper strap are embedded in the slots and joined to form a closed multi-circuit winding, which is cross-connected, like the multi-circuit winding of a direct-current generator. The basis of the insulation is mica. A preventive winding is connected between the commutator and the main coils, introducing a preventive action which is effective only when the coil is passing under the brush.

During operation a forced circulation of air, supplied by motor-driven blowers, enters at the rear, distributes itself thoroughly throughout the motor and escapes through the perforated cover over the commutator. This system of forced ventilation, which is applied both to motors and to auxiliary apparatus, secures a maximum output from a given weight of material and a high ratio of continuous output to the one-hour motor rating common in railway practice. It also provides effective ventilation while the locomotive is not in operation, as the blower may be driven while the locomotive is standing at the station or the end of the line. Motors ventilated in this manner are enclosed and are thereby protected from internal damage by dirt and water and from mechanical injury.

The two views, Figs. 3 and 4, show the external appearance of a motor and of a motor mounted in operating relation to its driving axle.

The control equipment is a multiple-unit system, of standard Westinghouse type, with pneumatically operated unit-switches and circuit breakers, and low voltage control circuit. Any unit may be controlled from either end, and two or more units may be coupled together and operated from a single cab and by a single crew. The tractive effort which can be readily applied to a single train is therefore limited only by the number of units available, and the hauling power is limited only by the mechanical strength of the coupling between locomotive and cars. A control circuit is carried from one unit to the next by means of connecting sockets and jumpers in the usual manner.

Speed control of the driving motors is secured by variation of the voltage at the motors, obtained by means of taps taken from the winding of the auto-transformer, which receives current

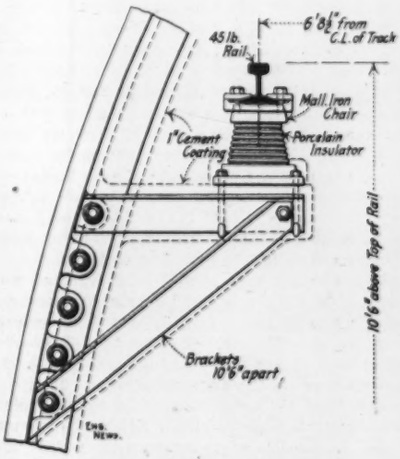


Fig. 6. Side-Rail Conductor and Support, St. Clair Tunnel.

from the trolley at 3,000 volts and reduces it to 240 volts (or lower, according to the tap employed). These taps are connected to unit-switches, from which current is led, through the preventive coils to the motors. Four unit-switches serve to reverse the field of each motor. The unit-switches are of standard Westinghouse design and are in effect pneumatically operated circuit breakers, with rolling and sliding contact, in which the arc is broken at the tips, leaving the contact surfaces smooth and unscarred. Each unit has a magnetic blow-out coil, with laminated core. The switch cylinders are controlled by

magnetically operated valves, current for which is obtained from a 50-volt tap from the auto-transformer. The sequence of operation is governed by the master controller, in conjunction with a system of interlocks, which prevents short circuit of the steps between taps from the auto-transformer or improper operation of the controlling mechanism. At any running point four controlling switches are closed. Through preventive coils, approximately the same amount of current is drawn from each of these switches and the leads to which they are connected. To change to a higher voltage on the motors the master controller is moved to the next notch, opening the last switch of the group that is closed and closnig the switch next higher, with the result that the motor voltage is shifted up one step. By this arrangement the voltage at the motor will be completely under control of the locomotive driver and may be varied up and down at will without opening more than one-quarter of the load current. Small switches in the circuits to the magnets of the reversing switches will enable any motor or combination of motors to be cut out without disturbing the others. There are 17 controlling connections, each of which provides an efficient running point. This number is thought to be ample to prevent any slipping of the driving wheels due to increase of current from one notch to another.

All high-voltage wiring in the locomotive is to be carried in grounded brass tubing.

Each locomotive unit will be equipped with a pneumatically operated pantagraph trolley to collect current from the overhead lines outside the tunnel and throughout the yards. The proportions of the pantagraph will be such that when extended it will make contact with the trolley wire 22 ft. above the rail, and when closed down the contact shoe will not extend more than 18 ins. above the roof of the locomotive. A further current collector may be provided, for use in the tunnel, as noted further below.

TRACK SUPPLY AND DISTRIBUTING SYSTEM.

Outside of the tunnel the line current will be supplied to the locomotives by an overhead central wire over each track, 22 ft. above top of rail, suspended from a messenger cable, so that the trolley-wire is approximately in a straight line. The messenger wire is carried on transverse bridges of structural steel work, arranged to cover two to nine tracks, as required by the varying conditions. At a few places brackets on side poles will be used in place of bridges. The bridges will be spaced generally 250 ft. apart. They are designed for a vertical load of 800 lbs. and a possible horizontal pull of 7,000 lbs. from each wire, and wind pressure on 30 sq. ft. of area for each trolley. At either side of each bridge will run a ⅝-in. steel cable, connecting all bridges throughout the length of the yards, as further security against failure of any bridge-tower. These two side cables will be pulled up to 1½ ft. sag.

The messenger wire is a ⅝-in. galvanized steel cable, of 25,000 lbs. minimum breaking strength, pulled up to 36 ins. sag when loaded, at average temperature. The trolley wire is 4-0 grooved copper wire in the yards, and 300,000 circular mil grooved wire on the approach grades. It is suspended from the messenger cable by galvanized steel hangers, 12½ ft. apart, adjusted in length so that at maximum temperature the trolley wire has a slight sag and is about level at minimum temperature, to obviate danger from contraction of the trolley wire.

For the tunnel, two methods of arranging the conductor are under consideration. The preferred style employs a conductor rail, supported along the side of the tunnel, 10 ft. 6 ins. above the track, on brackets attached to the wall. A 45-lb. rail is used, bolted to malleable iron chairs, cemented on porcelain insulators, which are seated on the brackets. The brackets and the neighboring portion of tunnel wall are covered with 1 in. of cement. The brackets are to be bolted to the tunnel shell in the manner shown in the detail, Fig. 6, and are to be placed 10¼ ft. apart, or at every seventh segment. Laterally the rail is 4 ft. 4¼ ins. from the gage line. It is laid in regular lengths, and bonded with 350,000 circular mil bonds. This construction is shown in relation to the full tunnel section in Fig. 5, at the left, as adapted to a single track. But it is possible that the tunnel track will be gauntletted to avoid switches at the ends. This will shift the conductor rail from the position shown in Fig 5 and will probably require two conductor rails, one on either side. The detail, Fig. 6, represents more correctly the proportionate length of bracket for this case.

An alternative arrangement which has been proposed by the contractor is an overhead trolley-wire construction, with messenger-cable suspension. This is shown in Fig 5, at the right of the center line. Cross-pieces of treated timber, supported by iron hangers from the tunnel shell, carry insulators, over which a 7-16 in. steel cable is laid. The cross-pieces are spaced 15 ft. apart. The trolley-wire, 15 ft. 2 ins. from top of rail, is hung from the messenger cable, which latter is frequently braced by spreaders. At the left in Fig. 5 is shown the arrangement of overhead trolley-wire indicated in the Consulting Engineer's specification, where the trolley-wire is directly supported by insulators attached to the tunnel roof. The contractor's design, at the right, skilfully utilizes the very scanty clearance in the roof for the less compact "catenary" suspension.

The current collectors on the locomotive will depend upon the type of tunnel conductor installed. If the overhead wires are employed the "pantagraph" trolley which is provided to collect current outside the tunnel will serve also in the tunnel. If the side rail is adopted, an additional collector will be fitted, consisting of a contact arm, adapted to be pressed down on the top of the conductor rail, held by a linked frame fitted with springs. When the air pressure is released the frame folds together downward, and the contact arm folds upward, bringing the whole device close against the side of the locomotive. An automatic cutout renders the collector frame "dead" in this position.

The track rails are to be bonded, for the return current, by 2-0 B. & S. gage bonds at each joint of each rail outside the tunnel, and 300,000 circular mil bonds in the tunnel. Cross-bonding every 500 to 1,000 ft. will be provided.

The point where the generating station will be located is on the Port Huron bank of the river, about 1,600 ft. from the west portal, over a shaft extending down to the tunnel. The electric conductors are to be carried down this shaft.

The traction current will be supplied by two single-conductor paper-insulated lead-covered cables of 800,000 circular mils cross-section, extending down the shaft and connected at the bottom to conductor-rail and track rail, respectively. The cables for power to the pumping plant are three-phase cables, carried in tile ducts in the tunnel located as shown in Fig. 5 and covered with concrete. The tunnel lighting, yard lighting and roundhouse light and power cables are also carried through the tunnel. These are all high-voltage, three-phase cables, from which taps are taken, either directly or through transformers.

POWER PLANT.

Located over the Port Huron shaft, as just noted, the power station will have good facilities for coaling and an abundant supply of cold water. It is designed to use steam-turbines, with high super-heat and high vacuum, and has its power concentrated in but two units.

The original specification called for three 800-KW. turbine generator units, but the contract was let on an alternative proposal for two 1,250-KW. units. These generators will furnish the entire output of the station. Two exciters, one driven by a steam engine, the other by an induction motor, of 40 KW. output, will form a duplicate source of exciting current. Water-tube boilers, fitted with mechanical stokers, will furnish steam for the station; four boilers, each of 400 HP. rating, are required. The Consulting Engineer's specification for boilers required, among other things, the following:

> Bidders will guarantee boiler to be adapted for the fluctuating load indicated by the load curve. If boilers are of the B. & W. type, each boiler is to have three 42-in. drums and have 21 rows of tubes, each nine tubes high. If boilers are of other types, it is desired that the [illegible] capacity be increased at least 20% over the [illegible] design,

to give greater heat storage, and thereby [illegible] better coal economy than the very fluctuating load shown by Fig. 2 would otherwise [illegible] possible.

The main feature of interest in the power plant is the turbo-generating equipment. The turbine part of each unit is of the regular Westinghouse-Parsons construction, and is, roughly, 15 ft. long by 6½ ft. wide by 8½ ft. high, weighing 67,000 lbs. It operates at the normal speed of [illegible] r. p. m., and uses steam at 175 lbs. gage, and 28/30 vacuum. It is intended to operate normally with 150° F. super-heat. Under this condition a steam consumption of 12.8 lbs. per H.P.-hr. at full load is expected. A maximum speed variation from full load to no load and vice versa is specified to be 2% or less. A safety stop for excess speed, and a secondary governor for overload, will be provided. The turbine bearings will be of bronze, self-alining.

The generators, each direct-connected to its steam turbine will be rotating-field machines, producing 25-cycle, three-phase current and 25-cycle single-phase current at 3,300 volts pressure. The efficiency of the generator, at 100% power factor, will be in excess of 95%. A 24-hour full load test at 100% power factor is required to produce no greater heating than 35° C. temperature rise in any part of the generator. The armature will be of slotted drum type, formed of steel laminations, pressed into the generator frame, and having wound coils in partially-enclosed slots.

The excitation of the field will be so controlled that, with constant speed, constant separate excitation, with load of 100% power-factor, the load may be varied from no load to full load with no sensible effect on the voltage.

As was noted at the beginning of this article, the pumping plants now existing at the two portals are to be replaced by electric pumping equipment. The present pump-houses at the portals will be used for this machinery. The plans provide for the following units, all to be driven by three-phase 25-cycle induction motors:

Motor-driven Centrifugal Pumps.

No.	Capacity Gals. per min.	Head, ft.	Motor, h. p.	Speed, r. p. m.	Combined Effic'y Motor & Pump,	Location.
2	5,500	90	200	480	57%	Sarnia Portal.
2	4,000	75	150	480	52-56%	Port Huron "
2	150	90	15	710	27%	Sarnia Portal.
Motor-driven Triplex Pump.						
2	150	90	5	710	53%	Tunnel.

The motors of the 5,500-gal. and 4,000-gal. pumps are 3,000-volt machines, while those of the small pumps take 400-volt current.

The above list represents a complete duplicate equipment. Considering one-half of this installation alone, the capacity is about 14,000,000 gals. per day. It is intended that the large pumps shall be operated only during and after rainfalls, while the small pumps will operate intermittently once or twice a day. The triplex pumps are placed on the wall of the tunnel at the bottom of the Sarnia grade.

The tunnel is not lighted at present. With this electric equipment it will be furnished with electric lamps. Regular 16-CP. incandescent lamps will be placed along the side walls, at about mid-height, spaced 25 ft. on each side and alternately, so that there will be one lamp every 12½ ft. Two separate three-phase cables from the power-house will supply these lamps by means of transformers distributed on the three phases in balanced arrangement.

ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF CEMENT USERS.

The second annual convention of this Association was held at Milwaukee, Wis., on Jan. 9 to 12, and the large attendance, the character of the papers, the active interest in the proceedings and the large and varied exhibits of materials and machinery all bore strong evidence of the importance of the cement and concrete industry. Engineers, architects, contractors and supply men were all present in large numbers, so that

both the technical and the practical or manufacturing phases of the use of cement were well represented. About 950 persons registered at the meeting hall. The headquarters were at the Republican House; the meetings were held in the West Side Turner Hall, and the exhibits were displayed on both floors of this building and of the Freie Gemeinde Hall, nearby, while some of the larger concrete mixing machines were ranged in the street. The list of exhibits and exhibitors, which is given in our Construction News supplement, indicates the importance of this feature of the convention.

The opening meeting was called to order about 3.30 p. m. on Jan. 9 by Mr. R. L. Humphrey, President of the Association, and after a few brief preliminaries the regular program was taken up.

CONCRETE AGGREGATES.—This paper, by Mr. Sanford E. Thompson, was read by the Secretary in the absence of the author. The sizes of sand and of stone and the relative sizes of those in a concrete mixture were discussed, and for ordinary concrete a 3-in. size of stone was recommended, with 1-in. or ¾-in. as the maximum in reinforced concrete work. The measure of the voids in sand is of little value, owing to the varying moisture and other properties of different samples; the better plan is to compare the voids in the mixture of cement and sand. While it is still customary to specify "sharp" sand, there is little reason for this, and the author doubted whether sand is ever rejected because it lacks in sharpness. The sand should, however, be clean. By increasing the richness in cement, good concrete may be made with almost any kind of stone, and for small local work it is often more economical to use an inferior local stone with an excess of cement than to bring in a better quality of stone.

The discussion was opened by Mr. R. A. Cummings, who stated that he had been engaged in investigations on the same line and considered the paper the best exposition of the subject ever presented. By the selection of proper aggregates he had succeeded in making a waterproof mixture with proportions of 1 to 3 to 7. There was an animated discussion as to the question of "clean" or "dirty" sand, Mr. Seafert strongly advocating the admixture of a certain proportion of clay, basing this upon tests made by various technical schools and by the Chicago, Milwaukee & St. Paul Ry.; these have already been published in our columns. He also stated that one maker of concrete building blocks uses clay in his mixture. Mr. C. A. P. Turner (Minneapolis) thought a small proportion of clay might be a benefit, but in reinforced concrete work he would prefer a clean sand, especially as in such work the proportion of cement may vary as much as 40%, according to the mixture. Other speakers thought the value of clay in sand for concrete to be very far from being proved, and it was further suggested that the character of the clay or dirt in itself would probably have an important influence in the matter. Mr. Humphrey thought that fine silt or hard clay finely pulverized might have no effect, and that soft clay or "mud" would be detrimental. Mr. A. L. Johnson (St. Louis) spoke of his practice of grading the sand and using specified proportions of fine sand and coarse sand in the mixture. The importance of climatic conditions in relation to the curing of concrete work was also referred to, more especially in regard to concrete blocks. Such blocks (especially when made up of a "dry" mixture) should be kept in a moist atmosphere and not merely sprayed intermittently.

A paper on sidewalk construction was read by Mr. G. L. Stanley (Ashtabula, O.), and dealt with the use of salt in concrete; tests with cubes set in fresh and salt water with the temperature at 10° F. were noted as having been made at the Case School of Applied Science, and these indicated that for temperatures of over 10° a 15% addition of salt might safely be used. Mr. Driscoll (Appleton, Wis.) spoke of laying sidewalks which could be walked upon in four hours after being laid, and which were as strong and durable as those covered with wet sand and kept wet for a week before being used.

At the evening meeting the President, Mr. R. L. Humphrey, gave an address, illustrated by a number of lantern slides, representing a variety of structures built of concrete. His paper reviewed the history of cement, concrete and reinforced concrete, the variety of structures now built of concrete and the numerous investigations which have been undertaken in recent years to determine the properties of concrete and to develop the making of concrete on a scientific basis.

STEEL FOR REINFORCEMENT.—In this paper Mr. A. L. Johnson (St. Louis) spoke of the work done in England about 1877 by Hyatt (an American) in designing and testing beams, etc., reinforced by both bars and stirrups. Reinforced concrete was first experimented with in this country by Ransome in 1882, and his first patent for reinforcement by twisted steel bars was issued in 1884. Mr. Johnson advocated the use of bars which give a mechanical bond with the concrete, especially as the miscroscopic bond or adhesion between the cement particles and the pores or inequalities of the surface of a plain bar is likely to be broken after years of shock and vibration. It is sometimes objected that plain bars are used abroad, where reinforced concrete has been employed longer than in this country. His answer to this was that the mechanical bond is only required in beams, and that the use of concrete beams not only originated here, but has become much more extensive than their use abroad, so that in this respect American practice is far ahead of foreign practice. The latest Prussian government specifications reduce the former allowance for adhesion very materially and recommend some form of mechanical bond. Anchoring the ends of plain bars by turning them up, etc., does not accomplish any good, as the stress is in the body of the bar. For practical reasons many small bars are better than a smaller number of large bars.

On Wednesday morning the meeting was not called to order until nearly 10.30 o'clock, and there was so much noice and confusion due to the presence of exhibits in the hall that peremptory steps had to be taken to require exhibitors to cease displaying and demonstrating while the meeting was in session.

The first paper was on "Cement in Building Construction," by Mr. C. A. P. Turner (Minneapolis). We shall publish an abstract of this later, but it is of interest to note that his criticisms of "rock-face" blocks were warmly applauded. Mr. Seafert thought this style of face had the advantage of practically concealing hair cracks, which would be very unsightly on a smooth surface, but Mr. Turner replied that with properly made blocks there need be no hair cracks. In the discussion Mr. Condron referred to a test of an 8-in. reinforced concrete floor to 1,300 lbs. per sq. ft., over four times the working load (300 lbs.) without showing any sign of failure. This was on the eleventh floor of a 16-story warehouse building. He did not believe such tests were good for much, and thought that, while it might be of use to test a sample slab to destruction in this way, it was not wise to apply any such load (approaching very near to the theoretical strength of the floor) on part of a permanent building.

RELATION OF THE CEMENT MANUFACTURER TO THE CEMENT USER.—This paper, or address, was by Mr. R. W. Lesley (Philadelphia), who spoke of the difficulties met with in the development of the American Portland cement industry. The excellent results obtained and the high reputation which American cement now enjoys is due in large measure to the fact that the manufacturers and users of cement (represented by the associations of manufacturers, engineers, architects, etc.) got together and formulated specifications for cement which are now recognized as standard. The same action has been taken in regard to reinforced concrete, the properties of and requirements for which are now being investigated by committees which include not only manufacturers of cement and engineers skilled in concrete work, but also engineers skilled in structural steel work, who bring a critical element into the investigation which is of great advantage. The cement users' association should participate in this work, and on the same line he advocated the investigation of materials and manufacture of concrete blocks. Mr. Lesley referred particularly to the general lack of knowledge of what concrete is and can do, which condition is responsible for much of the defective work done, and he thought both the manufacturer and user of cement owed a duty to the public in educating it up to some general and correct understanding of concrete construction.

INVESTIGATION OF CEMENT, MORTAR AND CONCRETE AT ST. LOUIS.—In a short and interesting address Mr. R. L. Humphrey outlined the purpose and work of the comprehensive investigations now being made under the direction of the U. S. Geological Survey at St. Louis, which have already been described in our columns. He urged all members to write to their Congressmen, requesting them to vote for the appropriation of $100,000 now asked for this work, and at the business session in the afternoon a memorial to Congress for this same purpose was adopted.

CONCRETE BLOCKS.—A considerable proportion of the time of the convention was devoted to the consideration of various phases of the concrete block industry. At two sessions there was a general discussion, or species of "experience meeting," under the leadership of Mr. Pearson (New York), who guided the discussion and called upon various members for their experience and practice. The result was interesting, but not very conclusive. Stress was laid upon the importance of properly curing the blocks and of keeping them wet enough during this period, but many makers are in too great a hurry to use the blocks, with results which hurts the industry as a whole. One speaker keeps them 24 hours under cover and saturates them by passing them through a tank, after which they are kept wet for three or four days. Others let them stand only 10 or 12 hours after they come from the machine, then wet them down at intervals with a hose and keep lawn sprinklers at work all night. Mr. Sherer (Milwaukee) is experimenting with high-pressure steam and exhaust steam for rapid curing, and finds the former preferable. For ordinary curing in summer he keeps the blocks under cover for 24 hours and then removes them to the yard, where they are wetted from one to four times daily, according to the temperature and humidity of the atmosphere. Mr. Cummings (Pittsburg) has used granulated slag with success as a substitute for broken stone. In regard to mixing, it is general practice to first mix the sand and cement dry, and the dryer the sand the more easily the mixing is done. Mr. Stevens (Chicago) described the practice at one plant, where the water is first put in and then the cement; when these are well mixed the sand and stone are added. Only a few spoke of grading their sand in different sizes and mixing these to reduce the voids.

In regard to waterproofing, it was stated that the objection to most methods is the expense. It was also pointed out that an absolutely watertight block is not necessary or desirable, and if there is no porosity the blocks will sweat. One member considered that blocks properly made, of proper materials, and properly cured, would need no waterproofing. Mr. Stevens uses no waterproofing, his blocks having about the same absorption as granite. Another member uses hydrated lime in the facing; 1 bushel of lime to 150 gallons of water is strong enough, and the solution is added in the mixer. Mr. Mothershead (Indianapolis) also read a short paper on "Waterproofing." The coloring of concrete was briefly mentioned, and Mr. Stephens described an effective method of mixing the coloring material and cement by putting them into the mixer with a number of stones, thus converting the mixer into a sort of ball mill. The stones are afterwards screened out.

A paper by Mr. Gibson (Indianapolis) on "Cement Block Architecture" set forth the present limitations and defects, but the block makers became somewhat restive under the criticisms of

their work and methods. He urged that both building and art must be considered in architectural design. Mr. Watson (Toronto) followed with the report of the Committee on Art and Architecture. He in general agreed with Mr. Gibson, but took the position that the architect should prepare his design with a view to the material to be used, and not irrespective of whether his building was to be of brick, stone or concrete blocks. He illustrated a number of very attractive bank and other buildings in Canada built of concrete blocks dressed by hand in the same way as stone blocks. This work included not only plain blocks of various kinds, but also columns, capitals, arches and decorative details. Some of these are cast in molds made of a mixture of sand and plaster. Mr. Moyer read a paper on "Hair Cracks and Crazing on Concrete Surfaces." This was similar to his paper recently published in our columns.

Mr. S. B. Newberry (Sandusky, O.) gave a general talk upon the subject of "The Manufacture of Concrete Blocks." He advocated the use of a wet concrete, with as much water as can be used and still make a block firm enough to be handled. Machine mixing he regarded as essential in even a small plant, being so far superior to the use of shovels or hoes. The ordinary blocks should not be too large and heavy to be handled by one man, and he was inclined to think that the future style of block would differ materially from those now on the market. The machines should permit of blocks of various dimensions being made, to enable the builder to properly conform to the architect's plans. In regard to the design of blocks, he thought that the architect is the best judge of what is beautiful and artistic, and that he should inform the builder on this point, not leaving it to the latter and then complaining that the product is inartistic. One defect in concrete work is the "dead" appearance, as compared with stone or brick, but this can be remedied by proper treatment. He thought the rock-face block would certainly have to give place to something of better appearance. Mr. O. V. Miracle (Minneapolis) followed with a paper on "Causes of Failures in the Concrete Block Business," and Mr. J. C. McClenahan (New York) at the last session presented a paper on "Manufactured Stone."

MACHINERY FOR CEMENT USERS.—The committee on this subject presented a report outlining the equipment for a concrete block making plant. Mr. Angell (Columbus, O.) thought that many makers would want to go into the business with a less extensive plant than that suggested by the committee. Mr. Sherer (Milwaukee) finds the best way to handle the blocks is by cars, with portable tracks in the yard. He tried a trolley carrier, capable of carrying six or eight large blocks, but this was not so convenient for serving all parts of the yard. He now uses pneumatic tampers with great success, the blocks being heavier and more dense; while with one man less in the force the output was increased 55% over that with hand tamping. They work under 80 lbs. air pressure.

CONCRETE PILES.—A paper by Mr. Henry Longcope described the manufacture and use of concrete piles, but related mainly to those systems in which a steel form is first driven to form a hole, into which concrete is dumped. This includes the Raymond and Simplex systems, but very little was said as to concrete piles which are driven by a hammer in the same way as wooden piles. With the Simplex system the cylindrical steel shell is either slowly withdrawn as the concrete is deposited or is first filled with concrete and then drawn, the concrete being held down by a piston upon which the hammer head rests.

THE USE OF CEMENT AND CONCRETE FOR FARM PURPOSES.—This paper, by Mr. S. M. Woodward, of the office of Experiment Stations, U. S. Department of Agriculture, was in part a synopsis of a bulletin now being prepared in the interests of the farming community, showing the advantages of the use of cement and concrete for permanent structures, together with the methods and cost of use. The cost depends so much upon local conditions that general statements must be made with reservation, but at a meeting of the Illinois Society of Engineers and Surveyors the statement was made that a great amount of work on the farm can be built of concrete at a less cost than when built of wood.

Residences, barns, ice houses, silos, etc., may be built of concrete blocks or in monolithic construction. Concrete may be used for foundations for cellar floors, barn floors, feeding and watering troughs and mangers, hitching posts, steps and inclines, and for the pavement of yards, walks and approaches to buildings where mud is specially liable to accumulate. Where it is used for floor sand pavements upon which animals sleep, provision must be made for ample bedding in cold weather. Many kinds and shapes of posts, with various types of reinforcement, have been tried, and this seems destined to become an important field. There seems to be no doubt that cement pipe can be readily made, suitable for sewerage and drainage.

For irrigation work, cement pipe may be laid in place in a continuous line by a special machine, or may be made in 2-ft. lengths and laid with cement joints. For the latter, collapsable forms of sheet metal are in use and three experienced men can make from 220 ft. of 16-in. to 500 ft. of 8-in. pipe per day. A mixture of 1 to 4 or 1 to 5 of Portland cement and coarse sand is used, made dry enough to allow the forms to be removed as soon as the concrete has been well tamped. After standing for 24 or 48 hours the pipes are turned over, and they must be allowed to set for two or four weeks, during which time they should be sheltered from the wind and sun, and kept damp by being sprinkled two or three times daily. As soon as the pipe can be safely handled, the interior surface is washed with a mixture of neat cement and lime water to reduce the seepage, which otherwise is considerable while the pipe is new. One barrel of cement will make 80 ft. of 8-in. pipe (1 to 5), and the wash requires 1 lb. of cement per 2 ft. length; the cemented joints are made with a 1 to 3 mixture. Such pipe is ordinarily considered safe for heads up to 14 ft. In California, the price for jointed pipe is from 16 to 60 cts. per ft. laid (or 9 to 50 cts. at the yard) for 6 to 20-in pipe; continuous pipe cost 18 to 30 cts. per ft. for 6 to 12-in. pipe.

Reference was also made to the use of concrete for dams, conduits, flumes and other works for irrigation systems; the Gage irrigation canal in Southern California is also lined with a 1 to 4 cement plaster, about ¾-in. thick, laid directly on the clay; the clay is indented at intervals to form a key or bond with the facing.

CEMENT.—The matter of cement, of course, came in for incidental discussion at different times, and there were also some papers on this particular subject. The Committee on Testing Cement and Cement Products recommended that the Association should adopt the standard specifications already adopted by the American Society for Testing Materials, and other similar organizations. Mr. R. K. Meade (Reading, Pa.) presented a paper on "The Choice of Cement for Concrete Blocks," and Mr. E. S. Larned (Boston, Mass.) followed with a paper on "Observations Upon the Testing and Use of Portland and Natural Cements." Mr. Sherer, in explaining the proposed building ordinance for concrete block construction in Milwaukee, stated that none but Portland cement would be permitted.

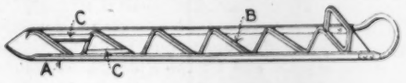
BUILDING REGULATIONS ON CONCRETE BLOCK CONSTRUCTION.—This subject was opened by Mr. Sherer (Milwaukee), who read the recommendations made by the men interested in the local industry for an ordinance which will be acceptable to the building inspector, the block maker and the public. It provides for a testing station for the compressive testing of blocks, and this has already been approved. The blocks are to be tested for the gross area, without allowance for any air spaces, and are to meet the requirements for brick. Mr. Palmer strongly objected to this, as not indicating the real strength of the blocks, but Mr. Sherer insisted that the idea was to get a plain and simple ordinance which would allow concrete blocks to be used on the same basis as brick. Mr. W. J. Scoutt (Chicago), representing a two-piece system of construction, read a paper on "Building Regulations for Concrete Blocks," in which he criticised the Philadelphia regulations as being too severe and too complicated, and the Chicago regulations as being practically prohibitive. These latter regulations were recently given in our columns, and we pointed out that they made no provision for the two-piece system. Mr. Scoutt explained that the building commissioner had ruled that this system would not be permitted under the ordinance, but that his company had, nevertheless, erected buildings by obtaining special permits from the council. Mr. R. P. Miller, Chief Engineer of the Bureau of Buildings, New York, also had a paper on this subject, and treated in a general way of "Legislation Concerning the Use of Cement in New York City."

The report of the Committee on Fire Proofing and Insurance was prepared by Mr. E. T. Lyons, chairman of the special committee on cement for building construction of the National Fire Protection Association. We shall give an abstract of this in a later issue.

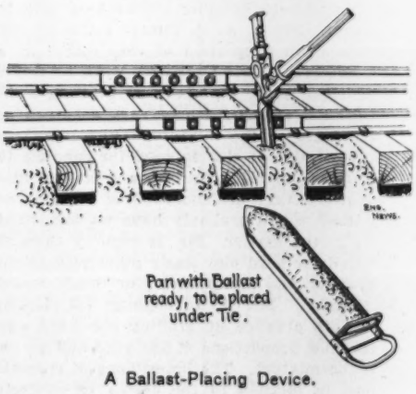
BUSINESS MEETINGS.—At the business meeting on the afternoon of Jan 10 the Secretary, Mr. C. C. Brown, read the report of the Executive Committee. This recommended that the Association should be incorporated under a charter from the U. S. Government, and submitted a form of constitution and by-laws. These were adopted, and the Executive Committee was authorized to proceed to incorporate the Association. The financial report showed the following: Receipts, $1,839; expenditures, $1,679; balance, $160. The by-laws put the selection of the place of meeting in the hands of the Executive Committee, and at the business meeting on the morning of Jan. 12 the President explained that without this provision it would be easy for the convention to select a place by popular vote, and thus tie the hands of the administration. The election of officers resulted as follows: President, R. L. Humphrey (Philadelphia, Pa.); Vice-Presidents, Merrill Watson, J. H. Fellows, O. O. Miracle and A. Monsted.

A DEVICE FOR FORCING BALLAST UNDER LOW TIES.

A ballast-setting device for use in raising low ties without disturbing the bed of ballast is in experimental use on several railways. It consists of a shallow pan, A, about the width of a tie and about 2 ft. long, with the bottom extended to a point and the sides cut away at this portion. At the back of the pan is a handle. In this pan lies a zigzag follower or bar of iron, B, having at its end two side bars, C, C. In using the device, the track is raised with a jack, and the pan full of gravel or



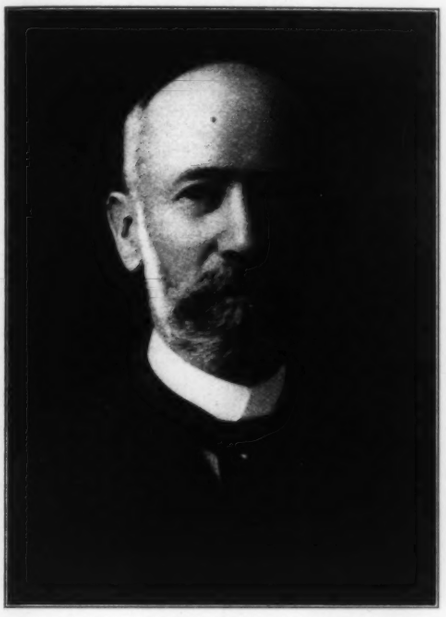
Pan with Follower, Complete.



A Ballast-Placing Device.

broken stone (with the follower in place) is pushed under one of the ties. The pan is then withdrawn, the zigzag follower keeping the ballast from being drawn out with it. This follower is then raised slightly by its handle, and drawn out, riding on the two strips, C, C; it thus levels off the new ballast but does not displace it.

It is claimed that the material is more uniformly distributed, and that it gives a more permanent support, as the bed of old ballast under the tie is not disturbed as it would be by the usual operation of tamping. It is further claimed that the work is more rapidly done and by a smaller number of men than under the usual practice of raising the track and tamping the ballast under it from each side. The device is manufactured by Walters & Okell, Fort Madison, Ia.



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The year 1905 will break all records for exports of manufactured goods from the United States. In some earlier years American manufacturers have devoted much attention to foreign markets when business was dull at home. In 1905, however, the home demand was brisk throughout the year, and yet the value of manufactured goods sent abroad exceeded even the record of 1904. While the complete figures are not yet available, the indications are that the exports of manufactured goods for the year 1905 will approximate 570 million dollars, as compared with 502 million dollars in 1904, the first year when the half-billion-dollar mark was passed.

The total value of United States exports for 1905 will probably exceed one and one-half billion dollars, and it is worth noting that, while manufactures are still considerably less than half of the total, the percentage is increasing year by year. In other words, the time is approaching when nearly all the raw products of our farms and mines will be used up here and the great bulk of our exports will be manufactured goods.

A letter which interested us, and we are sure will interest many of our readers as well, is reprinted below:

As I have dropped out of engineering for good, you will please cancel my subscription. I have been a subscriber to Engineering News ever since 1895, the year following my graduation from college, and it is certainly bidding farewell to an old acquaintance to give it up; but I have turned my back on the engineering business.

I have just torn up three pages explaining why a man would take four years' technical training, spend $2,500 and earn nothing during that time; follow the profession for twelve years through five States; spend $500 or $600 for an engineering library, and then at the age of 35 take up a new business.

I am not leaving the profession because I don't like it, but because it doesn't pay—me.

My experience ranges through levelman, transitman and resident engineer on railroad construction, city engineer for a town of 6,000, to resident engineer on construction of one of the largest manufacturing plants in the United States, where I was in responsible charge from the start until the arrival of my chief, six months later.

If I have any sons, they will learn bricklaying or plumbing in addition to a good general education, as it's my opinion the law of supply and demand will be complied with better by so doing.

A few months ago we made a comparison between the 40,000 practicing engineers and the 15,000 students in American engineering schools. We showed that more students by far are being trained for professional work than can possibly find employment in the profession proper. The result of this over-supply of engineering graduates is a sharp competition for places between the older men and these new recruits, who are willing to work for very low pay for the sake of experience. By the time these recruits have the experience, they have in turn to meet the competition of a new crop of graduates. The result is a forcing down of salaries in accordance with the law of supply and demand, and a constant crowding out of men into other occupations. The men thus crowded out in very many cases, we are sure, look back with regret to their investment in engineering education and experience, which is too often valueless to them in their new occupation.

It is frequently argued that this all tends to the general benefit of the country, since it is a struggle for survival of the fittest, and gives employers a wider opportunity for selection among engineers. There is, however, another side to this question; and that is the tendency of low salary rates, in the engineering profession, to drive the best and ablest men into other occupations. It is not mere opinion, but matter of common observation that the number who abandon professional engineering work for other more lucrative occupations includes not a few very able men as well as those of mediocre abilities.

We are not denying, of course, that at the present day there are many very well paid men in the engineering profession proper and a very much larger number in the various lines of commercial business closely connected with engineering. The man of unusual attainments, who stands head and shoulders above his fellows in the ability to do things—to accomplish results—to meet and overcome difficulties—such a man will make success for himself in whatever occupation he enters. From the very nature of things, however, such men are rarities. The great bulk of men who enter engineering or any other profession can never attain anything higher than average rank.

It is a fair question to raise, therefore, whether the youth entering an engineering school ought not clearly to understand just what are the relations of supply and demand in professional work, just what competition he must meet; and that his chances of future success will be greatly improved if he spares no opportunity to develop himself as a man; to cultivate initiative and independent thought; to develop his commercial sense and his powers of administration and execution. All these things will be of service to him in professional work, and of even more value than facility in work with the transit or the testing machine, if the time comes that he abandons engineering for some other occupation.

If instruction and training of the sort just specified is of value to the engineering student, then manifestly those who frame the courses of instruction in our engineering schools ought to recognize it and furnish such instruction. As a matter of fact, this is actually being done already to a not inconsiderable extent.

As an illustration we may note that one of the changes which followed the installation of President Humphreys at Stevens Institute was the establishment of a course of instruction on "The Business Features of Engineering Practice." The first text-book used, prepared by President Humphreys himself, has already been supplemented by an additional pamphlet, containing notes on commercial law relating to the relation of agents and principals, partnerships, negotiable instruments and the estimation and calculation of depreciation.

There was a time, and not so long ago, when the introduction of such matter into an engineering course would have been frowned upon in quite the same spirit that the supporters of the old classical course in the colleges frowned upon the introduction of instruction in modern science and engineering. But those times have passed.

A CALL FOR A BETTER ESPRIT DE CORPS IN THE ENGINEERING PROFESSION.

At a large public dinner of engineers in New York City last week, one of the speakers referred to the oft-repeated complaint that engineers are worse paid than the members of any other profession. He then made the striking statement that engineers would not be better paid until they had learned to have greater respect for themselves and for each other. No profession, said he, has so little real esprit de corps as the engineering profession; and in the interest of the whole profession and each member thereof this condition ought to be remedied.

We are reminded of this remark by the current public discussion respecting the conduct of matters at Panama. Speaking broadly, we may say that the United States Government has placed the entire responsibility for the conduct of the work at Panama upon the engineering profession. Nearly all the members of the commission which has the work in charge, and the responsible men in the employ of the commission, are engineers, and engineers, moreover, we believe all will agree, of high standing in the profession. Further, it will be agreed, also, that the selection of these engineers has been made solely with a view to their ability, integrity and reputation, so far as the responsible Government officials could determine this. At no time in this nation's history has the matter of party affiliations or political pull counted for so very little in the selection of men to occupy high and responsible positions as in the creation of the organization for the work at Panama.

We may go still further and remind our readers that the present organization of the Panama work was practically created at the request of the engineering profession. Had the Panama work taken the ordinary course and been turned over to the Corps of Engineers of the Army to be carried out, it would have been a very great hardship to these officers and their civilian assistants, who are limited by law to salaries ridiculously inadequate to the responsibilities that are laid upon them. That, however, is a minor matter, compared with the fact that it would have debarred the United States from procuring the high grade of professional service that it must have if the Panama work is to be done in the best and most economical manner.

All these arguments were duly laid before Congress and the Executive by men who may be fairly said to represent the engineering profession, and, as a result, the present law was passed placing the responsible conduct of the work in the hands of a well-paid commission, made up, for the most part, of engineers in the highest ranks of the profession. While some changes in the internal organization and personnel of the commission have been made, it is nevertheless true that the Panama Canal work to-day is organized on the basis that the engineering profession itself selected and recommended to the Government.

Under those circumstances we submit, it is the moral duty of the profession and of every reputable member thereof to stand by their professional brethren who are doing the work at Panama and bearing the responsibility therefor.

What do we mean by "stand by their brethren"? Well, it was once suggested that the Golden Rule was a better code of professional ethics than any that could be drafted. Perhaps if we say that an engineer ought to treat those in charge of the Panama work as he would wish to be treated himself if he were connected with the organization, it will be sufficiently definite.

We do not mean, of course, that the profession ought to excuse or condone or cover up incompetency, fraud or unfaithfulness of any sort on the part of any engineer, high or low. We do mean that engineers owe it to their professional brethren to believe in their innocence until proof of guilt is forthcoming. More than this, an engineer ought to stand up for his profession and defend its public reputation. It is not strange, perhaps, that, with the newspapers continually giving currency to sensational charges of graft and incompetence at Panama, the ordinary man

should attach some importance to these public publications; but an engineer ought to be wise enough and honorable minded enough not only to judge for himself and properly interpret such charges, but to defend in public and private his brother engineers when unjustly accused.

We have been led to these remarks by a perusal of the recently published articles of Mr. Poultney Bigelow. We referred to one of Mr. Bigelow's charges last week, and showed the absurdity of his alleged discoveries respecting the unsanitary condition of Colon. This, however, was but one of the things in which Mr. Bigelow arraigned the canal administration, and an effective and thorough reply to each and all of the Bigelow criticisms has now been publicly made by Secretary Taft himself. We strongly recommend any of our readers who have perchance been somewhat impressed with some of Mr. Bigelow's statements to address a request to the Panama Canal Commission at Washington for a copy of this printed reply. It is a very interesting document, but as one reads it the prevalent impression is one of regret that the Secretary of War and the Chief Engineer of the Panama Canal should have to take time and strength from the discharge of their many and great responsibilities to prepare an answer to the published charges of such an irresponsible sensation-monger as Poultney Bigelow.

The facts fully justify the adjective. It appears that Bigelow spent on the Isthmus exactly 28 hours—from 10 a. m. on Nov. 30 to 2 p. m., Dec. 1. As Secretary Taft well says:

> It would seem not to be a very long period in which to look carefully into and determine the character of the engineering difficulties of the greatest constructive enterprise yet undertaken by man, the efficiency of tropical negro labor, the healthfulness of a city, the proper place to put dredges, the proper amount of capacity to obtain from steam shovels, the character of the administration of justice, the proper position of hotels along the line of the road, the question whether a sewer system should be adapted to Panama at all, or whether the sewer system as established was sufficient for the purpose. Nor does it seem to offer the abundant opportunity for examining opposing witnesses on controverted issues which the writer of the article assures us that he had. The "many things on the spot" which he says he was able to examine must, therefore, be taken with some qualification. In view of the time which this critic—a man with no knowledge of engineering whatever—took to decide all the questions which arise in the construction of the canal and pronounce them of altogether vanishing difficulty, he should not take exception to the seven or eight days which twelve of the most distinguished engineers in the world in canal construction devoted to the same task.

Mr. Bigelow is not an engineer. His profound lack of knowledge of engineering is slightly indicated by his calling a steam shovel a dredge. But he has also proved his incompetence and unreliability as a newspaper correspondent. The first essential in a newspaper reporter—we are speaking now of reputable journalism—is the ability to find out the truth. He must find it often from conflicting sources of information. It is the common experience of the reporter to be beset with men who have private interests to serve or personal grudges to nurse. He has to consider always the reliability of his informants and to reject by a sort of intuition the story told by the prejudiced man, the one with an axe to grind or the sorehead with a grievance.

Mr. Bigelow, as above stated, spent 28 hours on the Isthmus, or a part of two days, some of which was occupied in traveling by rail from Colon to Panama and back. His personal knowledge of the Isthmus and the canal must be, to say the least, decidedly "sketchy." He supplemented this knowledge therefore by interviewing a disgruntled property owner and—we regret to say it—an engineer who has put himself on record as a vindictive and very ugly customer, with a large grievance against the canal administration, which he has taken extraordinary measures to air.

Mr. Bigelow paraded statements by such authorities with a flourish of trumpets before the American public as the real condition of affairs at Panama. It strikes us that he and those publications which gave his report currency were guilty of nothing less than a fraud upon the public, and a fraud of a peculiarly contemptible and despicable sort.

There is no greater service that a public journal performs than the fearless exposure of official misconduct or incompetence; but to attack public officials with false charges, purely for the sake of a sensation, is a scandalous misuse of the power of the press which goes far to paralyze its influence for good when real evils are to be uncovered.

We are glad to record that at least one journal which gave currency to Bigelow's charges (the New York Evening Post) frankly acknowledged in an editorial that their false and fraudulent character had been fully shown by Secretary Taft, and stated that Mr. Bigelow's unreliability had been so conclusively established that it would accept nothing henceforth on his authority.

The New York Sun also, under the expressive caption, "Crushing a Butterfly," refers sarcastically to Bigelow's flitting visit to the Isthmus, and says that the exposure of that fact alone by Secretary Taft is sufficient to discredit everything that Bigelow said.

Our readers will remember that in our last issue we devoted some space in our editorial columns to showing the absurdity of some of Mr. Bigelow's charges. We held that this was a plain duty of this journal, as representing the engineering profession. That duty, however, rested on every engineer as well as upon ourselves. If there were a proper esprit de corps in the engineering profession we believe that a hundred thousand engineers last week would have felt it incumbent upon them to take advantage of every opportunity in private conversation to express confidence in the Panama administration and contempt for Bigelow's silly stories. If such an influence were exerted whenever the profession is brought before the public it would have no small effect in molding and guiding public opinion.

We are not for an instant advocating—be it understood—that the profession should defend incompetence or dishonesty. When an Oberlin Carter is found out in professional ranks, let us disown him as promptly as possible. On the other hand, when an engineer or a body of engineers is held up to public criticism, do not his professional brethren owe it to themselves and to him to stand by the profession and to counteract, so far as their influence is able, that current which always tends toward condemnation of the accused?

On the other hand, this is a proper place to point out that the members of the engineering profession who have been chosen for the Panama work have a responsibility to discharge toward their profession as well as toward the country. It is within bounds to say that the reputation of the American engineering profession will hang on the work done at Panama. The engineers engaged there, from the members of the commission themselves down to the man entrusted with the smallest professional responsibilities, owe it to their profession as well as to themselves to give the best that is in them. So doing, they deserve the respect and confidence of their professional brethren and should be able to count on them for defence against unjust attacks.

We are glad to set it down that Bigelow appears to have found no disgruntled or discharged member of the engineering force at Panama to tell him a tale of scandal. We regret to set it down that Bigelow did find an engineer there, not in the Government employ, who, because of failure to secure a high position in connection with the canal work and because of unsuccessful endeavor to obtain Governmental favors for a private corporation in which he was interested, appears to have been more than willing to pour all sorts of calumnies into Bigelow's willing and capacious ear. For a full statement of this engineer's conduct we must refer our readers to Secretary Taft's published statements. We may only take space here to say that this man's published letter to President Roosevelt, attacking the advisory board of engineers and the canal administration is sufficient to cause him to be expelled from the engineering profession, if expulsion were possible, or at least from any reputable professional associations.

And now, in conclusion again, lest we be misunderstood, we are, in nothing that we have said, opposing or objecting to fair criticism. Such criticism ought to be welcomed by engineers, and they should not be too thin-skinned to take it in a proper spirit, even when it is unfavorable.

We have not written the above to defend the work or the workers at Panama. Doubtless there are things there that might be fairly criticised. Mistakes have been made, as they are always made, on every work that man undertakes. No one should object to have any such mistakes pointed out by a fair and competent authority. Nor have we written the above to defend the Panama engineers against the Bigelow attacks. Secretary Taft has exposed the character of Bigelow and his informants so thoroughly that anything we could say would be superfluous.

What we do desire is to induce engineers to properly respect themselves and the profession to which they belong; and we trust that what we have set down here may contribute in some small measure to that end.

LETTERS TO THE EDITOR.

Proper Methods of Heating Rivets.

Sir: In No. 25, Vol. LIV., of your paper, in an article under the title of "Burning or Overheating Rivets," the Department of Bridges of the City of New York's specifications call for rivets, if not equally heated, to be hotter at the head than the point, also that they must be heated in oil, gas or hard coal furnaces. It would be interesting to me and I am sure to many of the subscribers of your valuable paper to see the reasons for this, and also what the objections are to using a soft coal forge.

Yours truly, F. P. Buchanan,
Bridge Inspector, Canadian Pacific Ry. Co.
St. John, N. B., Dec. 29, 1905.

(We referred this inquiry to the Department of Bridges of the City of New York, and received the reply printed below.—Ed.)

Sir: The most difficult feature of bridge construction is to secure uniformly reliable riveting, principally field riveting. This is due to the apparently ineradicable determination of riveters in the field to facilitate their part of the work at the expense of the efficiency of the rivets by heating the points far more than the rest of the rivet, often to the cost of burning. Soft-coal forges make this easy in the case of all rivets and almost unavoidable in the case of long rivets. If there are soft-coal forges which compel or permit other conditions I have not yet found them.

If the efficiency of the riveting is the prime consideration, and not the pleasure of the riveters, the soft-coal forge should be eliminated just as far as possible. A very casual observation of the operation of furnaces and forges should make this easily apparent.

Yours truly, R. S. Buck,
Consulting Engineer, Dept. of Bridges.
13 Park Row, Manhattan, New York, Jan. 9, 1906.

More Concerning the Detection of Burnt Rivets.

Sir: Referring to the subject of burnt rivets I note that Mr. Gus C. Henning, in your issue of Jan. 4, 1906, states that he refers to pits in rivets while hot, when he states that a rivet that is pitted should be rejected.

Not one rivet is examined close enough to see pits while it is hot to a hundred that are looked at and tapped while cold. I do not think that "Subscriber" referred to the acceptance of hot rivets when he stated that various engineers had accepted pitted rivets. It is scarcely likely that engineers would be called in consultation over a pan of hot rivets. I do know instances where pitted rivets in finished work were the subject of consultation and of loud protest on the part of the engineers. The pitting was very generally attributed to burnt metal, until it was duplicated in good rivets by merely placing scale in the cup.

As to newly driven rivets being rarely pitted, I have found the opposite to be the case; unless the shop men are careful (as many have learned to be) to keep the lower cup free from scale in vertical driving.

Yours truly, Edward Godfrey.
Monongahela Bank Bldg., Pittsburg, Pa., Jan. 5, 1906.

Water Waste in New York City.

Sir: I read with great interest the editorial note upon water waste in New York City, published in your issue of Jan. 4. It very closely expresses my own views. You say, however, that the admirable work begun by ex-Chief Engi-

neer N. S. Hill, Jr., to detect and reduce waste is doubtless being carried forward. I have inquired about that and find that his work has been entirely discontinued; and so far as I can find there is nothing being done to prevent the known waste, which reputable engineers like Messrs. Croes and Crowell say accounts for one-half the water brought to the city. The per capita consumption is said to increase two and one-half times as fast as the population. Col. B. F. Church wrote fully upon this subject in 1902, and while urging that more water should be procured in ample time, begged the authorities to stop the waste, pointing out how it could be done and had been done elsewhere. The New York "Times," commenting thereon, said: "To spend millions to increase the supply that the present waste may continue unchecked would be a criminal misuse of the public money."

Under these circumstances do you wonder that taxpayers object to the recent decision of the city government to appropriate 92 million dollars in a lump sum as a mere beginning of this colossal scheme, five times as large as was ever voted before for any one scheme, so far as I can find out, and that before the State Commission had even held its first hearing, and, as you say, "not one dollar to prevent waste." Yours truly,

T. A. F.

38 Sherman Ave., Tompkinsville, New York City, Jan. 5, 1906.

Hair Cracks on Concrete Surfaces.

Sir: Referring to Mr. Albert Moyer's article on hair cracks on concrete surfaces and the prevention of same (Eng. News, Dec. 28, 1905), I should like to question him in regard to several points that come up in the every-day work of an engineer.

Where forms for some part of the work remain on a month or two, would not these forms protect the concrete sufficiently from the air and the sun's rays? Considering that they would, is there any benefit gained by wetting the older surfaces when the forms are removed? Considering that the forms do not protect enough, in cases where the forms must remain on the lower portions of the work until the entire job is finished, would it be possible to keep concrete damp by wetting the forms? This would, of course, make the forms practically worthless for future uses as such.

I gather from Mr. Moyer's remarks that a great help toward the prevention of hair cracks would be to do away with all shovel facing or surfacing with rich mortar, and substitute a mortar-poor in cement. This mortar could extend farther into the interior than facings usually do. It could be a good mix of the proportion 3 or 4 sand to 1 cement. Would this solution conflict to any harmful degree with the theory of voids in concrete? Yours very truly,

F. C. Harper.

815 First National Bank Bldg., Chicago, Ill., Jan. 11, 1905.

Bar Screens Wanted.

Sir: Will you kindly advise us what size bar screen we need for a capacity of 30 cu. yds. per hour to screen two products, sand and gravel, and also please advise us at what angle they should set. The material is a sand and gravel and is elevated and delivered to the screens by an endless chain. The screen is to be stationary. Do you know of any firm that makes such screens? We have tried several New York houses but they recommend us to make them for ourselves.

Yours truly, Hinman & Sproul.

Newton, N. J., Jan. 5, 1905.

(It should not be a difficult matter for any fairly ingenious contractor's foreman to make a screen to suit his special requirements. Flat iron bars, spaced the proper distance apart by washers, would be proper material for such a screen. Perforated plates could also be used, but are not so satisfactory for stationary screens as for shaking screens. We shall be glad to hear from any of our readers who can furnished detailed drawings of bar screens which they have found satisfactory.—Ed.)

Concerning the Use of Wrought Pipe Bends Instead of Cast Fittings in Piping.

Sir: It is only a few years since a multiplicity of fittings for pipe erection has been available. The old time piper shakes his head ruefully as he looks back to the time when all bends of every conceivable degree were made on the job. Of course the pipe then used was rarely larger than 2 ins., and, in fact, 1¼-in. pipe was then considered a big piping job. The facility or rather the ability of the then piper to put crooks and turns in a line of piping was wonderful, as he really had no appliances for doing such jobs. About the only tools he had were two deft hands, two good feet and a sturdy knee, frequently utilized as a former to bend the pipe around. He did not sit down and rest three or four solid hours while his "clerk" went possibly ten miles and back on the trolley to get an elbow for a ¾-in. or ½-in. pipe; not he; for no ells were to be had. Instead a bend would come from his hand and just grow into the line, and the entire job would be completed and the spry clerk would have the kit packed and ready for the next job.

This is not meant as a sigh for the good old times, but to note the fact that wrought pipe bends are now

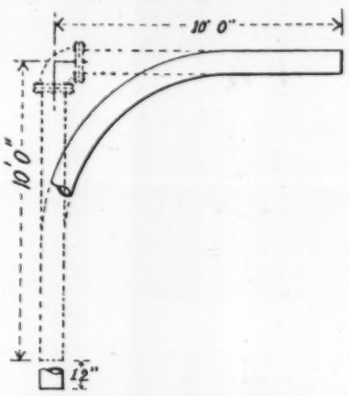

Fig. 1. Comparison of a Long-Radius Bend and a Cast-Elbow in a Pipe Line.

being forced into use again. The old time piper used them from necessity, as he had nothing else to use; and another kind of a necessity, namely, the greater steam pressure now demanded, which makes it unsafe to use cast iron ells, has again caused resort to bent pipe.

Coupled with this is the fact that the use of wrought bends will save money, not only in the erection of a line of piping, but every day that it is used.

As to first cost, if the intending purchaser of materials necessary to install lines of piping will take the time to figure the cost of a long sweep extra heavy cast iron ell, two extra heavy companion flanges, two corrugated copper gaskets, two sets of bolts, cutting two threads, and add to these items the cost of making up the two joints, he will find that for a 10-in. pipe the total will be close to $30. To carry the above sized line around a corner, see Fig. 1, it will take 18 ft. of pipe to measure 10 ft. each way in the run, allowing for the ell, and the same piece of pipe formed into a bend with the proper radius of about 8 diameters will reach a foot further along the line than the same pipe does with the ell used, and the entire $30 for the two joints is saved less the cost of bending the pipe. The bending ought to be done at a cost of not more than $8 to $10.

Besides the above, a great saving is effected by using bends in the cost of covering the piping, as well as the wear and tear of conscience in the risk of blow-outs at both sides of the ell or the rupture of the ell itself. The contraction and expansion of a line of piping may increase the strain on the elbow far in excess of its factor of safety. With modern piping it is also now possible to have a number of pieces of piping of any size welded together, thus obviating all trouble with joints, as well as the actual risk in their use. Such welds can be made more cheaply than ordinary joints. Fig. 2 shows four random lengths of pipe made up into one piece about 80 ft. long and making a 45° bend near each end, and this will reach as far around a corner in a line of pipe as five lengths of pipe with an elbow at the joining of the center line. In fair sized lots it is feasible to ship such bends complete from the shop, as they measure less than 74 ft. over all, and Oregon timbers 90 ft. to 100 ft. long are shipped across the continent. In any case, such bends as are described may be made of two or three welded lengths of pipe and shipped easily in lots on open cars and at an enormous saving over the use of ells, flanges, etc.

For water pipe lines for hydraulic work, about mines and for high head water power use, there certainly ought to be far more of such wrought bends used, both for results in use as well as for the saving to be effected in the first installation. Another great improvement in pipe construction is making joints by flanging the end of the pipe out, bringing the two abutting ends of the pipe into direct contact, as shown by Fig. 3. Such flanges can be supplied at trifling additional cost over the old style screwed flange, but are much better, and the flanges swivel. If properly made the joint is much better and stronger even than the more costly welded flange, as in the latter case the pipe is liable to cold-short as well as to burn in making the weld. It is also easier to erect as the welded flange will not swivel.

Another notable new improvement in piping is a divided flange (Fig. 4), to be used with the flanged-out ends above described. These divided flanges are very convenient to use in the cramped quarters where piping is often placed. The ordinary solid flange will slip back and forth on the pipe while it is being handled, smashing fingers, and being in the way generally, while the divided flange can be placed around the pipe at any time needed and made up the same as if solid.

In laying out a pipe system with wrought bends it is important to use the largest radius that can be gotten into position. Eight times the nominal diameter of the pipe to be bent is a good rule for the radius and often even a larger radius can be used. Bends can nearly always be used with random lengths as to the distance from center of line run to one end or both ends of the bend. The straight pipe used in connection with the bend can be cut readily to fit; but to cut the ends off a piece of pipe and thread it after it is bent is an altogether different proposition.

It is a great mistake to suppose that a buckle on the inside of a pipe bend is the mark of a bungling and worthless job. Actually it is far better to have a buckle than to so stretch the pipe elsewhere that it is attenuated and oxidized until its strength has gone. If the buckles are hammered out, the pipe may be knocked out of round, or reduced in size, and the metal may be so laminated and frayed out as to render it unsafe. The pipe is actually stronger to allow it to buckle a trifle, and as it is covered when in use, even the looks can make no difference. The writer recently saw a 10-in. return bend made for an expansion loop, on the advice of the engineering corps of a leading concern, and they recommended the making of this bend on a 30-in. center radius. Its making was undertaken by a concern with a good equipment and good men, and after breaking two or three pipes they finally got it down to a center radius of about 39 ins. The bend was so oxidized, however, that it was utterly worthless for the intended use, as it had no more elasticity than a bend made of cast iron. This is only mentioned to show the folly of trying to accomplish unnecessary things, as ample room could have been provided for making an expansion loop by welding up pipe and bending it on such a radius as would give proper flexibility after making. The bend above mentioned was looked upon as a necessity as it doubtless was in this case, if it had been made with proper radius, as above explained, but the same line of piping had three

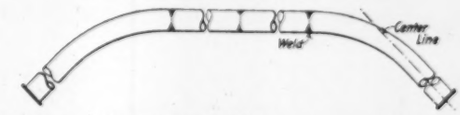

Fig. 2. Lengths of Pipe Welded Together for Long Bend.

Fig. 3. Pipe Joint with Loose Flanges.

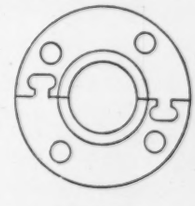

Fig. 4. Divided Flange.

ells within a few feet of each other where a bend would have done much better, and saved sixty if not seventy-five dollars of some one's money.

James Acton Miller, Mech. Engr.

Thompsonville, Conn., Jan. 2, 1906.

The Relative Value of Fresh and Caked Cement.

Sir: I note the communication regarding the relative value of fresh and caked cement in Engineering News of Dec. 21st, and send you herewith the result of some tests made by our cement tester, which shows clearly that the lumpy or caked cement is not nearly as strong as the fresh cement, not only for neat cement tests but for 1 to 3 mortar tests. The tests extend over a period of three years. I assume that the results would be about the same whatever brand of cement was used.

Yours truly, C. F. Loweth,
Engineer and Superintendent, Bridges and Buildings, Chicago, Milwaukee & St. Paul Ry.

Chicago, Ill., Dec. 30, 1905.

(The report of tests mentioned by Mr. Loweth is as follows.—Ed.)

Sir: Three years' results were obtained of a set of tests to determine the effect of air-set cement, i. e., lumpy or caked cement (Wolverine) due to exposure of air, especially damp air. Two samples of cement were taken

from a storage house, one sample of cement that was all lumps, and another sample of cement that was free from lumps and unaffected. The tensile results of these samples are as follows:

Cement.	Mixture.	7 days. lbs.	28 days. lbs.	3 m'ths. lbs.	6 m'ths. lbs.	1 yr. lbs.	2 yrs. lbs.	3 yrs. lbs.
All lumps	Neat	417	589	690	705	575	739	719
No lumps	"	686	756	798	858	776	857	805
All lumps	Mortar	131	244	326	373	374	372	373
No lumps	"	192	330	380	430	497	449	450

In the neat tests the lumpy cement is about 24% weaker than the cement free from lumps, and in the mortar tests the lumpy cement is about 23% weaker. It should be remembered, however, in making these comparisons, that the lumps in the lumpy cement were all crushed in mixing and kneading the paste and mortar. In regular work the lumps would not all be crushed, especially if they were quite hard, as some of these were. And so, in regular work the difference in strength between lumpy cement and cement free from any air-set lumps is apt to be greater, rather than less than these comparisons show.

Yours truly,

G. J. Griesenauer, Cement Tester.

Sir: Responding to your request, in issue of Dec. 21, for information concerning the strength of caked cement, would say that such tests were made at the U. S. Engineer Laboratory at Cleveland, O., in 1900, to determine the strength and effect of caking on a large consignment of Sandusky Portland Cement (Medusa Brand) that had been carried through the winter in cloth sacks, stored in a damp warehouse. Nearly all of this cement was more or less caked, but the bottom tier of sacks had become so hard that it appeared absolutely unsafe to use them. In order to settle the question, one of the worst sacks was selected for test, broken up under a heavy rammer, rubbed through a fine sieve, mixed neat and broken in usual manner. Nine briquettes were made of which 3 were broken in 7 days, 3 in 28 days and 3 in 6 months.

The results of these tests, as well as the results of comparative tests of fresh cement, made at the same time, in the same manner and by the same man, are as follows:

Tensile Strength of Sandusky Portland Cement. (Medusa Brand.)

	Hard caked cement. 7 d.	28 d.	6 mos.	Fresh cement 7 d.	28 d.	6 mos.
Average strength of 3 briquettes	430	575	710	645	650	770
Average strength of 3 briquettes	461	640	770	639	672	700
Average strength of 3 briquettes	468	645	760	656	711	755
Average strength of 9 briquettes	453	620	747	647	678	742

Cleveland, O., Jan. 3, 1906. G. T. N.

Sir: In the issue of Engineering News of Dec. 21, 1905, "Subscriber" makes inquiry regarding the strength of Portland cement that has become lumpy and caked from exposure to dampness. This question arose during the construction of the High Service Reservoir on Forbes Hill, Quincy, for the Metropolitan Water-Works in 1900, and some tests were made, the results of which I hand you herewith.

Respectfully yours,

C. M. Saville,

Division Engineer, Distribution Department, Metropolitan Water-Works.

1 Ashburton Place, Boston, Mass., Jan. 3, 1906.

Sir: Referring to the inquiry of "Subscriber" about the value of caked cement perhaps some experience of my own may help. On several occasions cement stored long enough to cake slightly has been given to me to work with. In every instance tests were made and there was no evidence of deterioration.

In one instance 200 sacks were stored in a shed through a hard winter. Before the cement was stored it was sampled and tested in the customary way. In the spring a question arose as to the possible harm done the cement and it was all sampled and tested again. We found absolutely no change.

The last instance occurred two winters ago. We had stored over 400 sacks in a carefully built shed at the beginning of winter and in the spring they were apparently all hard set. In fact, the first man in the employ of the company who saw the cement made such a bad report about the shed having leaked, etc., that I was severely reprimanded. Upon asking for an opportunity to look at the shed I was sent up and a careful examination failed to reveal any signs of water having run down inside. Neither was the floor broken nor were any of the sides bulged to let snow in as had been reported. The sacks were as hard as though set.

I had them all taken out of the shed and piled in the sun. They were put back in the evening after having been somewhat roughly handled by the men. Every one was surprised to see how the cement softened up in the sun. Only a few sacks had to be beaten with shovels or clubs. No tests were made for strength but I made a number for soundness and they all showed up well. When using the cement the men were instructed to look carefully for lumps and throw them out. Out of the four hundred and odd sacks about ten piled on the floor close to the door were spoiled. In perhaps twenty-five there were some large hard lumps. The rest were all right and made good concrete.

Before that winter on a job where about one hundred sacks had become hard we rigged up a hopper with a bottom of No. 40 mesh wire screen. Each sack was dumped into the hopper and a man scraped on the bottom with a wooden hoe. The dust was bad and we afterwards made the bottom rounding and put a revolving scraper inside like the scraper in a flour sifter such as may be found in every kitchen. This pulverized practically all the lumps.

So long as the cement does not set the hardening of the outside after long storage does not seem to hurt it. The conversion of free lime into a hydrate as the result of long storage argues in favor of it.

Yours truly, Ernest McCullough

P. O. Box 691, Chicago, Ill., Dec. 22, 1905.

Sir: I note in Engineering News of Dec. 21 a letter upon "Caked Cement," in which the writer wishes to know whether pounding up caked cement with wooden mauls gives a cement which is as good as that which has not set up at all.

It is my judgment when the lumps are so soft that they turn to powder on being struck by a shovel, or as the writer states a maul, the cement is uninjured. I never knew any to be condemned for this light caking which results from long storage. We do, however, invariably condemn cement which is so caked as to form large lumps, which when pounded with a maul break into smaller hard lumps, and of course into some fine cement. It is impracticable to pound this into cement as fine as it was originally, and therefore if the cement had not been uninjured otherwise, you could not get as good results as with cement that had never set up at all. Caking varies between lumps the size of a pea, to that of a whole barrel. Frequently we simply pick out the hard lumps and throw them away and use the balance of the cement which is still in the powder. Some years ago I had tests made of the cement of a number of barrels which had been stored in a damp place (and alternatively wet and dry place) for a period for about a year. These barrels had caked solidly throughout almost the entire barrel. The caking was such that it was impracticable to pound it up into anything resembling ordinary cement. I broke a number of samples from these barrels and had them ground fine in a laboratory, and tested for tensile strength in 1:3 mortar. My recollection was that the cement according to these tests had lost 50% of its strength in 28 days. I enclose herewith a test made

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Tests of Atlas Portland Cement That Had Become Lumpy and Caked Next the Bagging Where Exposed to Dampness.

Note.—The cement had not set hard, but could easily be pulverized by hand, all tests given below were made by the same operator and under similar conditions on the same machine.

	Activity — Mins. to bear Light Wire.	Mins. to bear Heavy Wire.	Tensile strength Lbs. per Sq. In. 24 Hours.	7 Days.	28 Days.	3 Mos.	6 Mos.	9 Mos.	1 Yr.	2 Yrs.
Neat Cement.										
Lumpy cement	220	595	287	568	635	650	708	706	763	791
Number briquettes averaged	12	12	12	12	5	5	5	5	5	5
†Cement in ordinary condition	151	445	585	782	...	...	...	...	...	...
Number briquettes	12	12	12	12	...	...	...	...	...	...
ϕCement in ordinary condition	59	331	423	664	718	745	757	...	750	822
Number briquettes	...	...	4,356	4,346	2,296	490	275	...	183	39
Mortar 1 Cement, 2 Sand.										
Lumpy cement	...	360	...	311	377	396	392	421	429	407
Number briquettes	...	12	...	12	5	5	5	5	5	5
†Cement in ordinary condition	...	305	...	291	...	...	...	...	...	...
Number briquettes	...	12	...	12	...	...	...	...	...	...
ϕCement in ordinary condition	...	417	...	284	401	470	446	...	402	398
Number briquettes	...	...	...	4,169	3,141	523	291	...	191	58

†Samples taken from inside of same cement package from which lumpy cement was taken.

ϕAverage tests of Atlas Portland cement used in the construction of the Weston Aqueduct, 1901-4, Inclusive. An. Rept. Met. W. & S. Bd., January, 1905, p. 209.

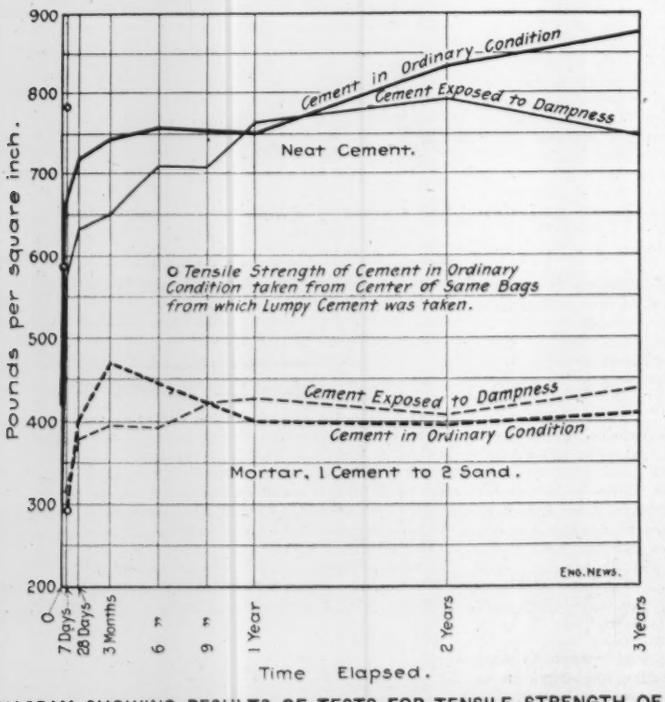

DIAGRAM SHOWING RESULTS OF TESTS FOR TENSILE STRENGTH OF ATLAS PORTLAND CEMENT THAT HAD BECOME CAKED AND LUMPY FROM EXPOSURE TO DAMPNESS.

Table Showing Effects of Air Hardening on the Tensile Strength of Portland Cement.

	Neat cement. 1 day in water.	1 day moist air and 7 days in water.	1 day moist air and 27 days in water.	3 parts sand. 1 day moist air and 7 days in water.	1 day moist air and 27 days in water.
	lbs.	lbs.	lbs.	lbs.	lbs.
1	286	592	626	196	258
	242	460	604	228	282
	256	478	632	214	270
	270	510	578	230	292
2	296	582	588	222	266
	310	710	706	264	312
	276	624	646	230	286
	330	600	674	242	270
3	76	132	262	48	130
	124	196	296	70	142
	82	174	204	50	126
	96	152	230	54	172

1. Air set; full of hard lumps, and outer bags of pile set hard. An average sample taken and crushed so that all cement passed a 50 mesh sieve.
   - Per cent. of water to make stiff mortar, neat cement 20
   - Per cent. of water to make stiff mortar, 3 parts sand 10
   - Temperature of air and water ..... 70°
   - Coarser than 100 mesh 26%
   - Initial set .....Hours 3
2. Sample same as No. 1, but all coarse lumps removed using only the cement that passed a 50 mesh sieve.
   - Per cent. of water to make stiff mortar, neat cement 20
   - Per cent. of water to make stiff mortar, 3 parts sand 10
   - Temperature of air and water ..... 70°
   - Coarser than 100 mesh 12%
   - Initial set .....Hours 3
3. Sample same as No. 1, using the hard lumps and coarse cement left on 50 mesh sieve, sample crushed so that all cement passed 50 mesh sieve.
   - Per cent. of water to make stiff mortar, neat cement 18
   - Per cent. of water to make stiff mortar, 3 parts sand 8
   - Temperature of air and water ..... 70°
   - Coarser than 100 mesh 35%
   - Initial set .....Hours 3

by Mr. J. C. Hargrove which may be of general interest to the profession. This hard caked cement, which I have invariably condemned on important work, has been frequently used advantageously by the contractors. They pound it up as fine as they can get it and use it, and get very excellent results. As a rule they make it a good deal richer than they would if a better cement were used. The Cranford Paving Co., of this city, recently built on their own property an 8 ft. span arch about 150 ft. long of caked cement, which as far as eye inspection

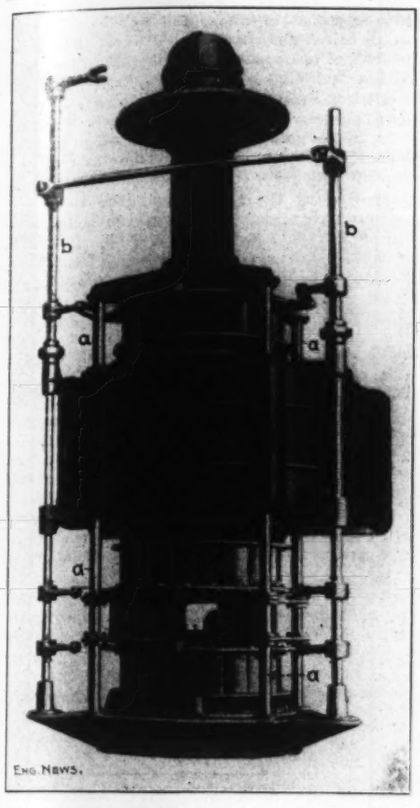

Fig. 1. Water-Turbine, Concord Electric Co., Sewalls Falls, N. H.
Allis-Chalmers Co., Milwaukee, Wis.

goes is about as good as any concrete I have seen. I doubt if any experienced engineer would hesitate to use caked cement where the caking was a small portion of the bag or barrel, particularly where the load on the concrete was well within the proper working stress. I mean by this that concrete, which for foundation work is frequently only stressed up a few tons per sq. ft., would permit of the use of such material, whereas, in important arch work where the stresses run as high as 18 to 20 tons per sq. ft. it would be necessary to condemn all such cement. Engineers permitting the use of caked cement insist on more cement of this class than is required under the specifications for first-class cement.

Very respectfully, W. J. Douglas,
Engineer of Bridges, District Columbia.

Washington, D. C., Jan. 3, 1906.

Notes and Queries.

G. A. C., St. Paul, Minn., writes:

Can you or readers of the Engineering News advise me as to the practicability of increasing the light in the court of a building by means of reflectors? The case under consideration is a court 31 ft. by 78 ft. in a seven-story building, the 78-ft. side extending north and south. Adjoining this building on the north side is an eight-story building which could be used for mounting the reflectors.

T. W. C. requests information as to experience in locating soundings in shallow water with the aid of a cable. He proposes to anchor one end of ¼-in. to ⅜-in. cable 500 ft. to 1,500 ft. long on the shore and secure the other to a winch on an anchored boat. Soundings will then be taken along the cable with a lighter boat. He understands this method has been successfully used by Government engineers in the South, and would like any information as to size and quality of cable, height above water, weight of anchors, floats used, method of tagging cable, etc.

E. H. C., of Marion, O., wishes to learn through the columns of this journal whether any of our readers have had practical experience with both plunger and centrifugal pumps connected to a system of wells. If so, he would like to know whether it is possible to draw the water down to a lower level with a centrifugal pump, due to the constant velocity of the water, as compared to its more or less varying velocity in the case of a plunger pump. He says that it would seem that such would be the case, but that he does not ask for theories in regard to the matter, wishing only the results of actual experience. To make the information of value it would be necessary to know the size and type of each pump, size and layout of wells and suction pipes, rate of pumping, maximum lift of each pump under the given conditions, etc.

"Reader" writes:

For pile driving, we are using a 2,000-lb. hammer with a drop of 25 ft. and we need to use a 3,000-lb. hammer now. To get the same amount of penetration of pile through just the same kind of soil and every thing in the same condition, how high must this 3,000-lb. hammer be placed?

The 2,000-lb. hammer falling 25 ft. will deliver a blow of 50,000 ft.-lbs., neglecting friction; and a 3,000-lb. hammer would have to fall 50,000 ÷ 3,000 = 16⅔ ft. to give a blow of equivalent energy. It is probable, however, that the lighter hammer striking with greater velocity expends a larger part of its energy in brooming the pile-head than the heavier hammer does, and the loss from friction is also probably greater. It is probable, therefore, that a fall of 14 to 15 ft., and in soft ground perhaps even less, would be as effective as the 25-ft. drop with the 2,000-lb. hammer.

Referring to our reply to a correspondent who inquired as to the relative range of projectiles fired from light and heavy guns, in our issue of Dec. 21, we are in receipt of a letter in which the following quotation is made from a treatise on "Ordnance and Gunnery," by Lieut. Jas. H. Ward, U. S. N.:

The velocity of a ball depends upon the quantity and strength of powder by which it is projected, and has no direct relation to the weight of gun. A high proportional charge of powder will produce high velocity and range; and will produce this effect whether from a light or from a heavy gun. But if this velocity of shot be produced from a light gun, the velocity of recoil will be so great that no breeching can confine the gun within the limited space afforded by a ship's deck. Hence it is that light guns must, to keep their recoil within manageable limits, have light charges of powder; which light charges, and not the weight of guns, is the direct cause of reduced range of shot fired from guns light in proportion to their shot.

It was supposed that the great recoil of light guns had the effect to decrease the range of shot fired from them, and that heavy guns, which recoil less, would, with the same charge of powder, give greater range.

To test this point Dr. Hutton, by direction of the British Government, instituted a set of experiments in 1795. He slung a light gun in chains, so that it might have free recoil. Fixing this gun he accurately noted velocity and range; also recoil in arc. He then successively increased the weight of gun by lashing to it bars of iron, and again firing successively with the same charge, noted the range and recoil at each discharge. Finally, he secured the gun so that it could have no recoil. By these experiments Dr. Hutton determined that as the weight of the gun increases the recoil decreases; but that decreased recoil or absolutely no recoil, has no effect on the velocity and range of shot.

There is on this subject, extensively existing in the navy, a popular error, which is so firmly rooted that it reluctantly yields, even to so high an authority as Dr. Hutton.

The date of publication of the book from which the above quotation is made is not given; but from its quotation of an experiment, made in 1795, we judge it must be a pretty old specimen. No one at the present day, we judge, would attach any practical importance to gunnery experiments made a hundred and eleven years ago.

If our correspondent will refer to Metcalfe's "Ordnance and Gunnery," Chapter X., p. 4, he will find it clearly stated that the work done on the projectile is reduced by the amount of the energy of the explosive diverted in other stated directions, among which is the production of recoil. While in ordinary guns only a very small percentage of the energy goes to produce recoil and there would be no practical difference in range between a gun of ordinary size and one of such size as to produce no perceptible recoil, still the fact remains that the greater the energy spent in recoil the less the available energy to drive the projectile forward.

A WATER-POWER ELECTRIC PLANT USING VERY LOW AND VARIABLE HEAD, AT SEWALLS FALLS, N. H.

An extremely interesting problem in the utilization of a water-power with a small fall and large variation of head for the production of electric current has been solved in the design of two 900-HP. turbines which the Allis-Chalmers Co. has built and is now installing at Sewalls Falls, N. H., for the Concord Electric Co. The first installation will consist of two complete hydro-electric units, each composed of a triplex turbine water-wheel and direct-connected alternating current "Bullock" generator, a motor-driven exciter set, turbine governors and electrical synchronizers.

As the current is to be used chiefly for lighting purposes and possibly in connection with other sources of power generation, it is necessary to maintain a very low speed variation, even though the amount of developed power may differ under different heads.

Ordinarily the stream produces a fall which gives a net working head of 16 ft. In times of flood, however, the water backs up in the lower channel and the tail-race, so as to reduce the working head to 12 ft.

THE TURBINES.—To secure the desired results each turbine was designed with three sets of runners and gates complete, the three sets being arranged one above the other on a vertical shaft. The runners, as shown in Fig. 2, are 55 ins. in diameter, of non-corrosive bronze, and each cast in one piece. They are all connected to the tail-race by means of draft tubes, so as to derive the full energy of the water, due to its actual head, from each of the runners, no matter what its relative or actual position may be upon the shaft. The lower runner of each wheel has a draft tube by itself, while a single tube of larger dimensions carries off the discharge water from the two upper runners. The turbines are of the Francis central discharge type. The three runners on each wheel are each of equal size, form and capacity; but they do not all discharge in the same direction. The lower one discharges downward into an individual concrete draft tube. The upper runner discharges downward, and the

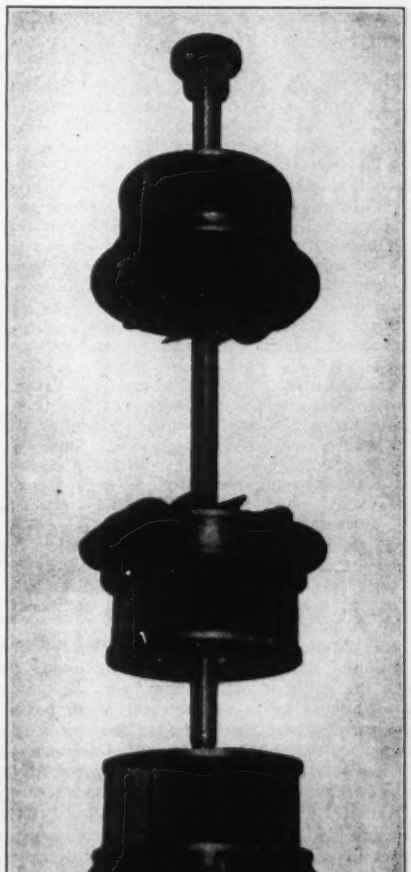

Fig. 2. Turbine Runners and Shaft.

middle one upward, both into a separate concrete draft tube, which joins the lower one at the bottom of the tail-race. The reactions from these two runners practically balance one another, while the reaction from the discharge of the lower runner, being upward, tends to lift a portion of the load on the turbine shaft. This effect is considered negligible in the turbine design, but provision is made for using the pressure due to the

head of water to actually carry a considerable part of the weight of the turbines and the generators at all times. This is done by admitting the water of the flume into a space directly under the second runner of each turbine, where it exerts its pressure upward against a circular plate, which forms a revolving piston. The water will carry about one-third the weight of the rotating parts. The other two-thirds is carried by a thrust bearing supported by the castings of the turbine.

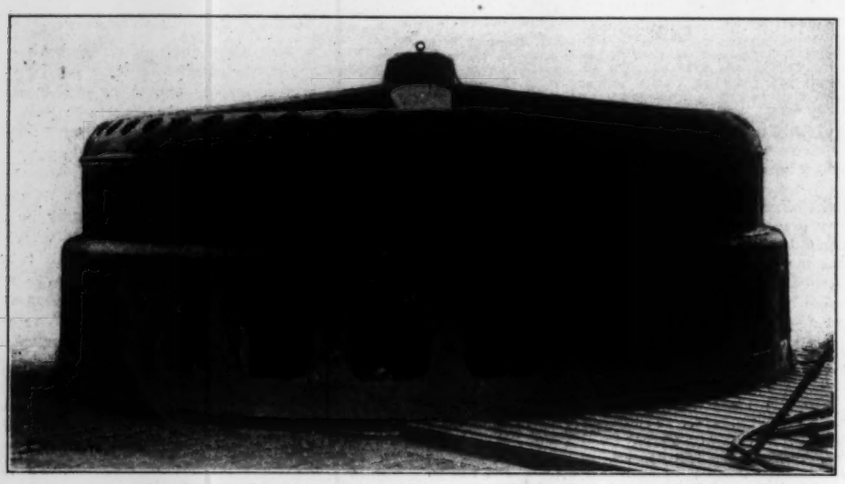

FIG. 3. GENERATOR STATOR FRAME OF HYDRO-ELECTRIC UNIT.

This bearing is made of generous proportions, so that there will be sufficient lubrication from the oil without putting the latter under pressure. The lubrication is, in fact, provided for in an ingenious manner by means of a well, formed outside the bearing rings and filled to a suitable height with oil. The oil flows to the inner part of the bearing through suitable holes, passes through the bearing, guided by proper grooves, and is returned through other holes to the well. The circulating action is automatic and is continuous as long as the wheel is in action. At two points below the thrust bearing the shaft is kept in line by steady bearings, carried by portions of the wheel casings. The wheel casings are self-supporting, besides carrying the weight of the rotating parts, one section being built on top of the other, and each provided with four stout columns (a, a), Fig 1, to carry the weight. The casings are steadied and held against vibrations and side strains by having certain parts carried over to the walls of the draft tubes. These walls and the draft tubes are of concrete, the whole being built as one solid structure of monolithic character. The wheel cases are all divided so as to permit of dismantling without disturbing the shaft or generator parts, and are put together with machined and ground joints.

Surrounding each runner are the gates which admit the water to it and control its speed. Outside the gates of each runner, and reaching all around it so as to admit water to all parts of the periphery of the wheel at once, is a space ample for that purpose. The gates are composed of movable guide vanes and so contructed that when open they admit a full head of water with but little interference, and when closed totally exclude the water. They are all connected by links to a common gate ring, and this in turn is operated through two countershafts (b, b), Fig. 1, standing parallel to the main shaft. These are each provided with a crank at each set of gates, and the cranks are connected to the gate rings by links. One-eighth of a turn of the shaft completely closes the gates. An energy of not more than 12,000 foot-pounds is all that is required for this operation.

GOVERNORS.—Power for operating the gates is provided by a governor for each turbine, placed on the generator floor beside the respective generator. They are of the Allis-Chalmers standard type of self-contained, oil pressure, hydraulic governor, so designed that no changes in arrangement will need to be made should three or more units be added to the plant, as such additions are not unlikely after two or three years. The permissible variations in speed under sudden variations of load are shown in the following table:

Variations of load per cent.	Permissible variations in speed.
25%	Not over 2% in 1.5 seconds.
50%	Not over 4% in 2 seconds.
75%	Not over 6% in 2.5 seconds.
100%	Not over 8% in 3 seconds.

Each governor is driven from a horizontal shaft running under the floor, which takes its motion from the main shaft of the turbine through the medium of a bevel gear. The bevel wheel on the main shaft is formed by attaching a toothed rim to the outside of the collar of the coupling which joins the two portions to the shaft. A "Morse" silent chain gear, which is encased, drives the governor from the horizontal countershaft.

The actual control of the gates is accomplished through the agency of oil under pressure, operating through the medium of a piston controlled by a pilot valve. This valve is regulated by sensitive fly-balls working against knife-edges. The governors are so arranged that they may be controlled electrically from the switchboard, and synchronizers and motors for controlling the governors, form a part of the outfit for the station. This makes it possible to increase or diminish the speed of either of the units at pleasure, or to shut down the units from the switchboard in case of an emergency.

TURBINE EFFICIENCY.—Operating at the normal speed, 100 r. p. m., the wheels each designed to produce 900 HP., with a 12-ft. head and a consumption of 620 cu. ft. of water per second, or 625 HP. at 12-ft. head, with a flow of 650 cu. ft. per second. Working at full gate, they are expected to economize 78% of the power of the water, or more, and to give 80% return at three-fourths gate. At half-gate they are expected to economize 75% of the power of the water.

GENERATORS.—The generators are of the Allis-Chalmers "Bullock" vertical water-wheel type, with upper guide bearing supported in a housing bolted to the stator frame. The stator or armature, Fig. 3, rests on a substantial cast-iron ring, supported by the foundation. The rotor or revolving field consists of a cast-steel spider, securely keyed to the vertical shaft and provided with dove-tail grooves in its rim for holding the laminated pole pieces, which are secured in place by tapered steel keys. The rotor shaft is direct coupled to the shaft of the turbine and forms the upper part of the turbine shaft. The weight of the rotor is carried by the thrust bearing of the turbine, but they have a steady bearing above the coupling to keep them in line. Each generator is designed to deliver a three-phase, 60-cycle current, at 2,600 volts, with a rated capacity of 500 KW. The guarantee calls for an efficiency of 94% at full load, 93% at ¾ load, and 91% at ½ load.

For exciting the alternators, a motor-generator set, consisting of a 75-HP. induction motor, coupled to a 45-KW. direct-current generator, is provided. The induction motor is wound for 2,600 volts, three-phase, 60 cycles, and the generator for 120 volts; the full load speed is approximately 680 r. p. m. Both machines are mounted on a common bed plate and the set has three bearings, two of which are carried in end housings bolted to the stator yoke of the induction motor.

We are indebted to the manufacturers of the electric and hydraulic equipment for the information given above.

TEST OF AN AUTOMATIC FIRE-PROOF CURTAIN SHUTTER.

An interesting test was recently made at the Columbia University Fire Test Ground, under the direction of Professor Woolsen, on a new

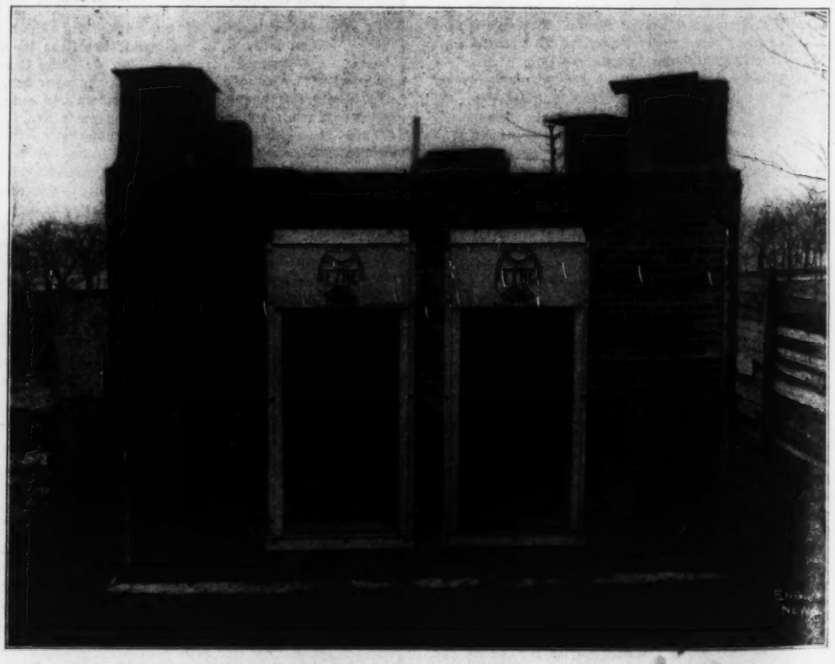

FIG. 1. AUTOMATIC FIRE SHUTTER, BEFORE TEST. AT THE COLUMBIA UNIVERSITY FIRE TEST STATION.
American Automatic Fire Curtain Co., Buffalo, N. Y.

fire shutter, manufactured by the American Automatic Fire Curtain Co., of Buffalo, N. Y. The test took place in a small structure, 9 ft. x 14 ft., built of brick and concrete, and supplied with numerous vents for draft. Two of the three windows, which were 5 ft. 9 ins. by 2 ft. 8 ins., were equipped with single curtains on the outside, while the third window had a double curtain, one on the inside and one on the outside.

The curtain is made up of uniform sections, as shown in the cut, each with a weather exposure vertically of 12 ins. and lapping an adjacent section by about 3 ins. Each section slides over the one above, the two being held together by individual guides, "a," Fig. 2, and all are contained in the cap above the window, when the latter is open. A bell-crank lever which holds these sections in place has its long end fastened to the inside of the window by a wire which contains a fuse. At the melting temperature of the fuse (155° F.) the lever releases the sections, and they, guided by grooves on the side of the window, drop down into position. The panels were made of No. 20 Gg. galvanized iron, while the rivets and individual panel guides were in some sections, of iron, and in others of aluminium.

At the outset of the test the vents and drafts were all closed and a fire started with the aid of kerosene oil, at 2:10. Temperatures were taken by means of pyrometers, in three different places. The fire burned slowly, but the curtains were released and dropped positively into place, at about 2:17, with an approximate temperature of 155° F. The temperature rose slowly to about 700° F., at which point it remained constant, demonstrating the ability of these shutters to confine the fire and hold the temperature down until the fire department has time to arrive. At 2:45 all the drafts were opened and the curtains subjected to the hottest fire possible for a breakdown test; the maximum temperature reached being 1527°. The shutters, made entirely of iron and steel, stood the test well, remaining intact throughout, but the aluminum rivets and grooves on the others melted at about 1000° F., opening the shutters.

The curtains were quite free from leakage of smoke, except near maximum temperature, and no fire was noticeable on the outside. The design of the curtain is such that the sections are free to slide in the grooves at low temperatures, but an increase in temperature and consequent expansion causes a tight fit, with no buckling except at very high temperatures.

FIG. 2. DOUBLE FIRE SHUTTER.
Outside shutter in fire position, and inside, open.

FIG. 3. AUTOMATIC FIRE SHUTTER UNDER BREAK-DOWN
Fire door open for adding fuel.

BUILDING CODE REVISION in New York City is meeting with difficulties. Some months ago the Mayor recommended to the Board of Aldermen that it give him authority to appoint a commission for the revision of the existing code. A resolution has now been introduced in the Board of Aldermen to appoint such a commission; but the joker lies in the proposed make-up of the commission, as specified by the resolution: the commission is to be composed of a builder, an iron-worker, a mason, a carpenter, a plumber, an architect, a civil engineer, a sanitary engineer, a physician, and a lawyer.

A REMARKABLE CAISSON ACCIDENT caused the death of four men in New York City on Jan. 16. A shaft is being sunk at the southern end of Blackwell's Island, in the East River, for a tunnel which is to connect the Borough of Manhattan with the Astoria section, starting from East 42d St., Manhattan. The shaft is being sunk as a pneumatic caisson, which is now down some twenty-five or thirty feet. An air compressor supplies air, feeding a receiver tank from which a line of pipe and a rubber hose carry air to the caisson at 8 to 10 lbs. pressure. On the morning of Jan. 16, when six laborers were in the caisson, a fire in this receiver, apparently of the redoubtable "compressor explosion" type, filled the caisson with smoke and gas from burning oil and rubber. The men in the caisson knocked for help, and as soon as possible the air-lock was thrown open and the bucket lowered, manned by the superintendent and the foreman of the work. The rescuers succeeded in bringing out four men, two of these being dead when carried out. The bodies of the last two were not recovered until pressure was put on again and the water which had risen in the caisson was pumped out.

A PREMATURE BLAST in the outlet tunnel of the Shoshone Dam, which is being built by the U. S. Reclamation Service near Cody, Wyo., on the night of Dec. 22 resulted in the death of a drill runner and his helper. These two men were the only ones in the tunnel at the time of the accident, or the loss of life would have been greater. The noise of the explosion attracted the attention of a boiler fireman, some distance away, who immediately notified the government engineer in charge of the work. The lifeless body of Leatherman was found in the tunnel, but that of Brown had disappeared. Search was immediately begun for the body, but it was not found until the next day, lying at the bottom of the river on the opposite side from the tunnel mouth. From appearances it seems that the men were engaged in loading a hole with dynamite when the latter was prematurely exploded. No blame appears to attach to the contractor or the government engineers in charge of the work.

THE MOST POWERFUL SEARCHLIGHT EVER built was tested recently at the Brooklyn Navy Yard. The 20,000 candle power developed by the electric-arc is multiplied 100 times by a parabolic reflector, so that the effective power of the light is equivalent to that of 2,000,000 standard candles. The big light was constructed by the General Electric Co., at Schenectady, and is a duplicate of the one recently installed at Sandy Hook. While the ordinary searchlight lens is about 18 to 20 ins. in diameter, this particular lens is 60 ins. The positive carbon is 2½ ins. in diameter, and carries a normal current of 200 amperes, at about 50 volts across the arc.

A PRACTICAL COMPARISON OF THE VALUE OF elevators and escalators (moving stairways) for handling large crowds in department stores, was made by keeping a careful count of the number of people carried by escalator and elevators, respectively, in Macy's Department Store, New York City, and the "Boston Store" in Chicago, during the recent holiday season. During the month of December, up to and including December 24, the escalator at Macy's took, on an average, more people away from the first floor than all of the elevators in the entire building, and it has always carried many more passengers than the eight elevators which are in its close proximity. Although the greater number carried by the escalator may have been due somewhat to the novelty of the mechanism, the greatly decreased floor area occupied by the escalator would give

it a decided advantage. A noteworthy feature of the handling of the holiday crowds at the great new "Boston Store" in Chicago, was the absence of congestion and confusion, because the ascending and descending crowds were marshalled by the escalators and never allowed to come into conflict. This superior condition of affairs is quite in contrast with the handling of such traffic by ordinary elevators. The escalator used in these stores is the invention of Charles D. Seeberger and is manufactured by the Otis Elevator Co., New York City.

TRANSMITTING PHOTOGRAPHS BY WIRE has been solved in principle and the apparatus will be ready for general use as soon as a few technical improvements have been introduced, according to Professor Korn in a lecture before the Electro-Technical Association of Munich, as reported by the "London Standard." Experiments made by Professor Korn prove that it is possible to transmit a photograph, 6 or 7 ins. square, in a period varying from ten to twenty minutes. The distance of transmission was 100 miles, but Prof. Korn declares that equally good results would be obtained if the distance were 5,000 miles. The negative of the photograph to be transmitted is placed on a transparent glass cylinder, which revolves slowly and at the same time has a continuous axial motion, the combination of the two being a screw motion. A ray of light is thrown on this cylinder from the outside, by means of an electric lamp and lens, and when the ray of light reaches the interior of the cylinder it is brighter or darker according to the coloring of that particular part of the photograph through which it passes. In the path of the light-ray, inside the cylinder, and in series with the electric transmitting wire, is some selenium which has the property of changing its electrical resistance with a variation in the intensity of light. An increase in the latter decreases the resistance and thereby increases the current flowing. The receiving station consists of an electrical Nernst lamp placed inside a similar glass cylinder covered with sensitized paper. The intensity of light from this lamp varies with the strength of the current, controlled by the selenium at the other end. It thus reproduces the exact shade of the original photograph, providing the cylinders at each end have exactly the same uniform motion. It is expected that the time of sending a photograph of this size will be reduced to five seconds instead of ten to twenty minutes.

AN ELECTRIC RAILWAY AND LIGHTING PLANT for the city of Rio de Janeiro, Brazil, is to be established by the Rio de Janeiro Tramway, Light & Power Co., which has been organized by American and Canadian capital. It is proposed to develop power from falls on the Parahyba River (100,000 HP.), about 80 miles from the city, and falls on the Lagos River (40,000 HP.), about 50 miles from the city. The present requirements are for about 25,000 HP. The company has bought out the present car lines of about 125 miles. Mr. F. A. Huntress is General Manager and Mr. James Mitchell is Chief Engineer of Construction.

PERSONALS.

Mr. H. C. Shields has been appointed superintendent of the Lehigh & New England R. R., succeeding Mr. Daniel Hardy, who has resigned to engage in other business.

The contracting firm of K. & R. Tanner, civil engineers, has changed its name to Tanner Bros., and will occupy new offices at 608 Manhattan Building, St. Paul, Minn.

Mr. Robert B. Campbell, who has been connected with the Ransome Concrete Machinery Co., of New York City, has opened a New England office for the same firm at 6 Beacon St., Boston, Mass.

Mr. M. E. Biggan, of Buffalo, formerly with R. W. Hunt & Co., has been appointed manager of the inspection bureau of the recently organized Buffalo Testing Laboratory, Ellicott Sq., Buffalo, N. Y.

Mr. C. H. Quereau, formerly superintendent of shops of the New York Central & Hudson River R. R., has been appointed superintendent of electrical equipment of that company and will have charge of the electric rolling-stock.

Mr. L. H. Ehrbar has recently been appointed engineer of subway construction for the New York Telephone Co., to succeed Mr. H. C. Baker, who has accepted a position with the Abbott Gamble Co., contractors, 32 Broadway, New York City.

Mr. George M. Walgrove, an architect of 42 East 23d St., New York City, has been appointed Park Commissioner for the Bronx by Mayor McClellan. In his early business life Mr. Walgrove was associated with such architects as James E. Ware and George E. Harding, but for the past 18 years he has been in business for himself. Among the buildings designed by him were the Newark Presbyterian Church and the new north wing of Blackwell's Island Penitentiary.

Mr. John W. Hill, M. Am. Soc. C. E., formerly chief engineer of the Bureau of Filtration, Philadelphia, was unconditionally acquitted on Jan. 12 of the charges, recently brought against him of falsifying estimates and records, in connection with the Philadelphia filtration contracts. The Judge granted the contention of the defendant's attorneys that the jury be charged to acquit Mr. Hill on the ground that no evidence of guilt had been submitted by the commonwealth. Some of the events leading up to and connected with the charges against Mr. Hill were given in our issues of June 22 and 29, 1905, pp. 668 and 693, respectively.

The Pennsylvania Steel Co., Philadelphia, has announced the abolishment of the offices of general manager, superintendent and assistant superintendent, and in their stead the offices of metallurgical engineer, vice-president, general superintendent and assistant general superintendent are created. Mr. H. H. Campbell, general manager, becomes metallurgical engineer; Mr. J. V. W. Reynders, head of the bridge and construction department, becomes vice-president; Mr. John W. Dougherty becomes general superintendent, with Mr. F. B. Carney as his assistant. Mr. Thomas Earle will be head of the bridge and construction department.

Mr. Charles W. Staniford, M. Am. Soc. C. E., has been advanced from the position of hydrographic engineer of the Department of Docks, New York City, to that of chief engineer, at a salary of $6,000, succeeding Mr. John A. Bensel, M. Am. Soc. C. E., who was recently appointed Commissioner of the department. Mr. Staniford has been connected with the Department of Docks for the past 18 years, holding successively the positions of assistant surveyor, surveyor and hydrographic engineer. Previous to his connection with this department he held the positions of resident engineer in charge of a section of heavy construction in the building of the South Pennsylvania R. R., and division engineer of the Cumberland Valley Branch of the Louisville & Nashville R. R. Mr. Staniford graduated from New York University, in the class of '81.

Mr. Walter H. Sears, M. Am. Soc. C. E., has been appointed chief engineer of the Aqueduct Commission of New York City at a salary of $10,000 per year. Since the resignation of the former incumbent, Mr. J. Waldo Smith, M. Am. Soc. C. E., to become chief engineer of the new Board of Water Supply, Mr. Sears has been acting chief engineer, advanced from the position of division engineer. Previous to his connection with the commission he held the following positions: Chief engineer, Pawtucket Water Works, Pawtucket, R. I.; chief engineer, Stillwater Water Works, Stillwater, Minn.; chief assistant engineer, East Jersey Water Works, for supplying the City of Newark; chief assistant engineer, Rochester Water-Works, Rochester, N. Y.; department engineer, Commission on Additional Water Supply, City of New York. Mr. Sears is a graduate of the Massachusetts Institute of Technology in the class of '68.

Obituary.

Robert G. Erwin, of Hartford, Conn., president of the Atlantic Coast Line R. R., died recently.

T. R. Merritt, the projector and builder of the Welland Canal, and a well-known Canadian financier, died Jan. 11. Mr. Merritt was president of the Imperial Bank.

George R. Finch, president of the Finch, Pruyn & Co., lumber and paper manufacturers, died at his home in Glens Falls, Jan. 12. Mr. Finch was also a director in several other companies.

David Hammond, a pioneer bridge builder of this country, died Dec. 27 at his home in Canton, O. Mr. Hammond changed from the construction of wooden bridges to those of steel construction in 1864, when, with W. R. Reeves, he formed the Wrought Iron Bridge Co. of Canton, O. Later he became vice-president of that company.

Frank E. Snyder, M. Am. Soc. C. E., died at his home in Chicago, Ill., Dec. 23. Mr. Snyder practiced his profession of civil engineering for about ten years in the vicinity of Dallas, Tex., and in 1898 became principal assistant engineer on track elevation work in the City of Chicago. At the time of his death he was assistant engineer to Chief Engineer Dun, of the Atchison, Topeka & Santa Fe Ry.

ENGINEERING SOCIETIES.

COMING MEETINGS.

THE ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 20. Annual meeting at Philadelphia. Secy., Mr. W. L. Webb, 1122 Girard St., Philadelphia, Pa.

OHIO ENGINEERING SOCIETY.
Jan. 22, 23, 24. Annual meeting at the Great Southern Hotel, Columbus, Ohio. Secy., E. G. Bradbury, 85 N. High St., Columbus, O.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21. Annual meeting at South Bethlehem, Pa. Secy., R. W. Raymond, 99 John St., New York, N. Y.

ENGINEER'S SOCIETY OF WESTERN PENNSYLVANIA.—At the annual meeting, held Jan. 4, at Pittsburg, Pa., the following officers were elected: President, Julian Kennedy, vice-president, J. K. Lyons; secretary, F. V. McMullin; treasurer, A. E. Frost; directors, A. R. Raymer, E. K. Morse.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.—The annual meeting was held at Seattle, Wash., Jan. 6, 1906. The following officers were elected for the ensuing year: Mr. James D. Blackwell, president; Mr. H. H. Fuller, first vice-president; Mr. J. J. Cryderman, second vice-president; Mr. J. C. Jeffery, third vice-president; Mr. A. H. Dimock, secretary; H. W. Scott, treasurer; A. B. Coe, librarian; Milnor Roberts, J. M. Clapp, H. Day Hanford, C. H. Rollins, T. A. Noble, Theodore F. Rixon, Marvin Chase, C. H. Topp, directors.

MUNICIPAL ENGINEERS OF NEW YORK CITY.—The annual dinner of this society was held at the St. Denis Hotel on the evening of Jan. 10. The society has now a total membership of nearly 375, and nearly half this number were present at the dinner. Mr. Samuel C. Thompson, President of the society, acted as toastmaster, and among the after-dinner speakers were Messrs. Charles Whiting Baker, D. L. Hough, Geo. S. Rice, John J. McLaughlin, Past President Nelson P. Lewis and Geo. W. Tillson, the nominee for President for the ensuing year.

NATIONAL FIRE PROTECTION ASSOCIATION.—The annual meeting to be held in Chicago, May 22 to 24, promises to prove notable in the history of that active and progressive organization. In addition to the usual program, covering discussion and adoption of rules and specifications covering fire protection topics, the tenth anniversary is to be marked by commemorative address on the organization, aims and purposes of the Association, to be delivered by Mr. Uberto C. Crosby, United States Manager of the Royal Exchange Assurance, who is one of the founders of the Association, its only honorary life member and one who has been identified with fire protection work covering a longer period than is represented by the history of the organization. An additional feature of interest in connection with the meeting will be demonstrations to be given in the new testing station of the Underwriters' Laboratories.

RAILWAY SIGNAL ASSOCIATION.—The January meeting was held at the Grand Union Hotel, New York City, on Jan. 9. The first paper was presented by a committee appointed to investigate the use of storage batteries in signaling, and was read by Mr. I. S. Raynor, the chairman of that committee. After a review of the general field, it was given as the opinion of the committee that, leaving out the question of cost, from the standpoint of service rendered, storage batteries are preferable on account of their uniform and continuous supply of current, as compared to the unreliability of caustic soda batteries. The next paper was one describing the Mackenzie & Holland improved Sykes block signal apparatus, used on the East Bengal State Railways, presented by Mr. G. K. Rogers, of India, and read by the secretary. Other papers read were by Mr. H. W. Lewis, supervisor of signals, Lehigh Valley R. R., on "The Care of Storage Batteries," and by Mr. F. F. Fowle, of the American Telephone & Telegraph Co., on "Specifications for Line Wire."

THE ILLUMINATING ENGINEERING SOCIETY.—The organization of this new national society was completed Jan. 10 at the Hotel Astor, New York City. According to the constitution adopted at this meeting, the object of this society is to bring about co-operation between the illuminating engineer, the gas engineer, the architect and the fixture manufacturer, for the improvement of illumination. In spite of the large number of engineering societies which have been organized in recent years, there is none which covers the distinct field outlined in the constitution of this society. That there is need of an organization of this character is evidenced by the large number present and great interest shown at the first meeting, regardless of the fact that no concerted effort has at yet been made to bring the society before the public. Regular meetings will be held each month at the Hotel Astor, New York City, and also at Chicago, Denver and San Francisco, as soon as these branch societies can be organized. The annual meeting will be held in New York City in January of each year. Papers will be presented at the meetings and published as society transactions.

Officers elected for the ensuing year are: President, Mr. L. B. Marks, illuminating engineer; first vice-president, Dr. C. H. Sharp, of the New York Testing Laboratories; second vice-president, Mr. A. A. Pope, of the New York Edison Co.; secretary, Mr. E. L. Elliott, chief engineer of the Consolidated Gas Co., New York City; treasurer, Mr. W. R. Lansingh. In addition to the above officers, the following members were elected to the council: Mr. W. D. Weaver, editor of the "Electrical World"; Mr. Walso S. Kellogg, architect; Mr. E. C. Brown, editor of the "Progressive Age"; Mr. W. D'A. Ryan, illuminating engineer of the General Electric Co.; Mr. F. N. Olcott, electric and gas fixture designer. All communications should be addressed to the secretary, Mr. E. L. Elliott, 23 Broad St., New York City.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, January 18, 1906.

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Anything to reduce the number of technical journals devoted to a single general field, without at the same time materially reducing the amount and variety of information made available, seems sure of welcome these busy days. We therefore take pleasure in chronicling two consolidations, each involving two journals, which took effect with the beginning of this year. First, we note that the "Electrical World and Engineer," a weekly, has been consolidated with the "American Electrician," a monthly. Thus two papers having a great deal in common, and already under one ownership, are physically merged into one. The new journal will be a weekly, but the first number of each month will be available for separate subscription. The other consolidation merges the "Municipal News," a new weekly, having a special monthly number, with "The Municipal Journal and Engineer," a monthly which has been before the public for a number of years and which has been supplemented by a weekly news sheet. The latter will be expanded to contain matter of more general and lasting interest, and will appear under the same title as the monthly issue of the older paper.

If the consolidation of technical papers is a reason for congratulation, so is the purchase and expansion of an old industrial journal, instead of the establishment of a new one. The journal in mind is an old monthly, with a very limited field, known as "The Roadmaster and Foreman." Beginning with the January number the field of the journal named is broadened, its publisher and place of publication changed (the latter to New York), and its editorial staff enlarged and notably strengthened, and its name lengthened—most unfortunately and awkwardly, we think—to "Engineering-Contracting and Roadmaster and Foreman." As indicated by the new part of the title, the journal will now give attention to the contracting side of engineering; or, if one prefers, to the engineering side of contracting.

A fire insurance glossary is proposed by a committee of the National Fire Protection Association. In the interests of an improved technical terminology, we gladly give space to the substance of an announcement made by the committee and signed by its chairman, H. E. Hess, 32 Nassau St., New York City:

The Committee on Uniformity of Requirements is prepared to compile a Glossary of words, terms and phrases used in connection with the insurance business or the various trades, arts, and sciences with which that business has to deal, and which are more or less commonly used or referred to in the reports and standards of this association. To that end the committee will undertake to list and define any words, terms or phrases that may be sent for that purpose to its chairman. The committee will also be glad to receive suggestions of definitions along with the words in cases where members have already made research and determined the same. Words having a special meaning in connection with trades and manufactures different from that commonly given them; or words having a meaning in one section of the country different from that attaching in another section; or words given a meaning different from any set forth in the dictionaries; along with special terms and phrases of similar character are of the kind that, if furnished, the Committee will be glad to work upon.

The written language and the spoken language differ so much that an interpreter's services often seem necessary in changing from one to the other. A brilliant address, which carries its audience by storm, may, in verbatim stenographic reproduction, be absolutely wretched reading. The reports of the proceedings of some of our smaller engineering societies demonstrate that humbler efforts share the same effect. We quote an example from the discussion of a paper before the Blank Railway Club:

I want to differ a little from a quotation in the paper read by Mr. Taylor, in regard to the two that went after the pail of water, it making no difference how they got there. I would say it does make a difference how they get there; the man that goes there first gets back first. In regard to one notation in one of the letters where he speaks of damning with faint praise, where they don't have the material on hand; of course, it does sometimes occur that the standard material used on a division continually of one kind and another, might be castings, might be candle wicking, that if the mechanical department endeavors to draw it, and they find they do not have it on hand and have to wait a week, why, they feel like that, although they may not say it at the time.

The speaker doubtless meant something, and presumably he made himself clear to his hearers. But what did he mean?

The quotation does not represent an isolated instance, by any means. The proceedings of the smaller technical societies are full of similar passages. Apparently, the secretaries of these societies do not fully appreciate their editorial function; or possibly they place too high a value on stenographers' minutes. The large or authoritative societies generally show close attention on the part of their secretaries to the editing of proceedings. The small societies, however, have ample opportunity for improvement.

CORRESPONDENCE.

Citation of Authorities on Expansion of Cast Iron When Solidifying.

Sir: A review of "A Pocketbook of Mechanical Engineering," published by me, which appeared in your issue of Dec. 14, contains the following criticism: "There are also some misstatements; as, on page 57, 'cast iron expands when solidifying.'" The statement thus characterized as erroneous may be found in almost any work on Physics or Heat, under the topic of Fusion. Some of the works containing the statement as given in my book are: Preston, Theory of Heat (1894), page 275; Rankine, Steam Engine (1891), page 235; Barker, Physics (1892), page 300; Ganot, Physics (1898), page 333; D. K. Clark, Manual (1893), page 364.

Very truly yours, Charles M. Sames.

448 Jersey Ave., Jersey City, N. J., Jan. 3, 1906.

Review of Rowe's "Preservation of Timber": Correction.

Sir: I thank you very much for your review of the "Preservation of Timber," in your issue of Dec. 14, but am sorry that you passed criticism on the small print of some of the tables, probably overlooking the card inserted just before the business directory.

The hand-book was first compiled for the information of operators, mainly, and incidentally for those interested in establishing treating works; but it was an absolute necessity to the former as there was no publication extant furnishing this information, and so far as I know there is none yet, with the exception of the book you reviewed. There has been expended several thousand dollars and years of time with little return except in legitimate work in making plans and instructing operators for various railroads and other parties in the timber preserving business.

Thanking you for the kind notice, I am,

Very respectfully yours,

Samuel M. Rowe, M. Am. Soc. C. E.

364 Monadnock Block, Chicago, Dec. 19, 1905.

(The notice in question was, in fact, overlooked by our reviewer, as Mr. Rowe surmises. It reads as follows, and is self-explanatory:

There are a number of tables so small as to be read with difficulty. Full sized prints of the plans will be furnished at the regular price for such plans, and the tables will be furnished at small advance of cost —Ed.)

Thomson's Bridge and Structural Design.

Sir: In reply to Professor Jacoby's review of "Bridge and Structural Design," in the Literature Supplement to the Engineering News of Dec. 14, 1905, the author desires to state that the book is not intended to take the place of elementary works on mechanics, but to be a supplementary assistance to the many draftsmen and apprentices who have little or no theoretical knowledge of bridge design; and it was hoped that the practical explanations presented might enable them to perform their work more intelligently. A thorough and exhaustive preparation for the responsibilities of designing was not attempted, but inasmuch as the matter when presented in the form of lectures to junior draftsmen has proved to be of very practical value, it is now offered in book form in the hope that it may benefit others in the same way.

The preliminary articles are short because it was considered advisable to reach practical examples as quickly as possible, with the object of explaining the theories involved in work which most frequently confronts the practical draftsman. The moment of resistance, the moment of inertia and the radius of gyration of structural sections have been treated more fully because a thorough knowledge of these subjects is absolutely necessary before the student is able to understand the design of even the most simple structure, and much of this information is not immediately available in the ordinary text book.

The reviewer's suggestion that rule of thumb methods have been used is without foundation, as any impartial reader will see. The reviewer finds fault because the material is not designated in connection with column formulae on page 22. This was a slight oversight, but everyone should know that only steel has been employed in the manufacture of beams, channels, angles, etc., for several years.

The use of the letter l to represent the length of a column in inches in one place, and to represent its length in feet in another is fully explained in the text and cannot possibly lead to error. The same character is used in both cases to conform with general practice.

With reference to the rivet pitch in flange angles, the author is still of opinion that it is much fairer to use the shear at the center of panel in figuring the rivet spacing rather than the maximum at the end. This method gives the correct number of rivets required between the two points considered, and is only open to the slight objection that the rivets at one end of the panel may be stressed a little more, and those at the opposite end a little less than they should be. This objection, however, applies to a greater or less extent to all riveted joints. A very good reason for not using the maximum shear at one end of the panel in computing the rivet spacing is that this method gives an unnecessarily large number of rivets.

The three highway spans considered were chosen as examples because they are representative of a large number of bridges that have been constructed, and also because they serve well to illustrate various principles of design.

The pin-connected span is a typical American structure, and although it would never be used in frequented localities, it still has its field of usefulness in remote places, where transportation of material is difficult, where traffic is comparatively light and where it is imperative to observe the most rigid economy. Its bottom lateral system may be weak, but this defect appears to be counteracted by the floor.

It seems rather captious of the reviewer to refer to the typographical error on page 68, since the correct distance, of 17 ft. 3 ins., is given in several places in the drawing.

Some of the illustrations are disappointing, but the drawings were not originally made for publication and a few of them were reduced more than they should have been.

While the author fully realizes that his little book has

many shortcomings (which he hopes to remedy at some future time) he believes it will be found useful to the class of men for whom it was primarily written, and it must be kept in mind that a brief and practical review of any subject is an excellent preliminary step to acquiring a more thorough knowledge of it.

Yours truly, W. Chase Thomson.

Office Dominion Bridge Co., Montreal, P. Q.,
Jan. 2, 1905.

A Compact Text on Applied Mechanics, Revised and Condensed.

Reviewed by W. Kendrick Hatt.*

STRUCTURAL MECHANICS.—Comprising the Strength and Resistance of Materials and Elements of Structural Design. With Examples and Problems. By Charles E. Greene, A. M., C. E., late Professor of Civil Engineering, University of Michigan. Revised by A. E. Greene, Assistant Professor of Civil Engineering, University of Michigan. Second Edition. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 244; 90 figures in the text. $2.50 net.

Professor Greene, during his long life as a teacher of engineering, exercised a notable influence on the development of engineering education. A graduate of Harvard College and the Massachusetts Institute of Technology, and later trained along lines of organization and execution in the service of the United States Army and in the practice of civil engineering in railroad and municipal fields, he came to the chair of Civil Engineering at the University of Michigan in 1872, succeeding DeVolson Wood. For 31 years that university was the scene of his activity. He also carried on a large and varied professional practice in Michigan. His contributions to technical mechanics are well known, and his treatises on the graphical analysis of stresses in roof trusses and bridge trusses and arches have formed the basis of the practice of a large number of the present generation.

Professor Greene was evidently a forceful teacher and a source of inspiration to his students. It is in this respect that one finds a distinction between the routine instructor, who merely carries his classes in good order and with general satisfaction, and that teacher who really forms the minds of his students. The efficiency of the latter type of instructor cannot be estimated, for the students carry on and extend his work in all departments of technical science. Professor Greene's book on "Structural Mechanics" reflects a teacher of the character described.

Published in 1897, this book has become well known. It stands intermediate between the ordinary text book on Mechanics of Materials and such books as Johnson's Framed Structures. It does not discuss structures, such as arches or suspension bridges, roofs or trusses, and it omits the details of shop practice, but it includes the statement of the principles governing the arrangement of areas, rivets, etc., in the plate girder, and the distribution, number and size of rivets in riveted joints. The criteria for the position of a set of moving loads for maximum shear and maximum bending moment, usually omitted in works on Mechanics of Materials, are developed in this treatise. On the whole, however, it is to be compared to Merriman's Mechanics of Materials, in point of content.

The chief feature of the book is compactness of treatment without sacrifice of clearness of statement. Thus, the matter covered by Merriman in 480 pages is covered by Greene in 240 pages. Of course, Greene's text does not contain the completeness of discussion found in Merriman's treatise.

The book is evidently framed for use; and one who has studied mechanics and has the general fundamentals fixed in his mind will, in the shortest time, find out what to do, or the information necessary for action. The book will probably demand from the beginner a considerable effort in the way of thought and algebraic deduction. With a conscientious student, an experienced instructor and a small number in class, this compactness should be no objection; for dilution of statement does not add to clearness of enunciation, and it is the student's business, and to his interest, to go over the text until he understands it and until his way of thinking approximates that of the author. In this case the conceptions and exposition follow a natural method that should be agreeable to the mind of the student. Professor Greene is not like some writers, who leave their readers with a sense of irritation.

Some of the compactness comes from the omission of the obvious. The author states that formulas are not needed for solving problems in beams, and that the student will do well to accustom himself to use the data directly; and again, that formulas are of little or no value in designing ordinary joints and connections. This is borne out by the experience of most teachers: that the ordinary formulas for riveted joints, by an elaboration of a very simple matter, rather confuse than help the student.

An example of the author's admirable and compact style is the paragraph relating to those factors in the growth of a tree that influence the market product, and to such factors as seasoning, shrinkage, decay and preservation.

As a whole, the book is not hackneyed, but original in treatment, and grips the root of the matter. Like Merriman, the author subordinates the algebraic statement to the clear enunciation of the physical and mechanical relations.

The examples presented in the book are excellent, but for class use more are needed. It is part of the work of the instructor to see that the conditions of administration of his work are such that the student will be thrown on his own resources as much as possible. Thus in the necessary process of assigning problems to be worked at home it is desirable that each student have an individual problem. With large sections and a large number of students, such assignment, and subsequent discussion of the submitted work, is very onerous, but it is worth while. It would be an excellent thing if the authors of text books would issue a separate pamphlet of examples which could be changed from time to time to suit the purpose. Fraternity houses soon collect solutions of problems in their archives. Sanborn's problems are good for certain classes, but are not of the order suited to students of such books as Greene's, Merriman's, Church's, etc. Bovey's Theory of Structures is notably strong in number and variety of examples.

Professor Greene presents the complex subject of internal stress through the graphical method. The various theorems are stated in an easily grasped order of development and proved graphically. The figures almost speak for themselves, and after having studied the chapter, no one need be in doubt concerning the steps to take in finding the principal stresses in any given case. There are few treatises concerning which this statement can be made.

The treatment of the moment of inertia about various axes is also plain and well arranged. The author, however, has failed to mention the ellipse of inertia.

It is not a usual thing to find a new edition of a book shorter than the old. The new edition, now under review, contains 240 pages, whereas the 1897 (first) edition contained 268 pages; this, too, notwithstanding the insertion of explanatory and introductory sentences in various parts of the text. The chapter on materials is brought up to date and reduced by 6½ pages. The matter on wrought iron is re-written and cut down; the matter on steel and building stone is re-written and enlarged; new matter on paint, and on the effect of shearing and punching iron, is added; specifications for masonry are properly omitted; and the matter on Portland cement is re-written and enlarged.

In Chapter III., on Beams, 2½ pages are omitted. The algebraic work is condensed and intermediate steps omitted. In Chapter VIII., on Pieces under Tension, discussions of the eye-bar under flexure due to its weight, of the connecting rod, and of tension connections, are added. In Chapter IX., on Columns, certain mathematical developments that have proved of doubtful validity have been omitted. A statement of principles and of practice replaces mathematical treatment. The derivation of the Rankine formula is [illegible] some reason omitted; the formula is merely quoted with the statement that it agrees with a curve passing through points derived from experimental data.

Twelve pages are wisely omitted in the chapter on working stresses. The discussion of fatigue of metals in the old edition, covering [illegible] pages, has been condensed to 4½ in the new by omission of data and of such formulas as Weyrauch's, Seefehlner's and Gerber's, and of that admirable summary of Bauschinger's laws which may now be found reprinted in a bulletin of the American Railway Engineering and Maintenance of Way Society. The present uncertainty of the meaning of these experiments on fatigue, and the doubt as to their application to design, justify this latter omission. The discussion of the strength of timbers in this chapter is enlarged, and the entire matter on working stresses has been revised to correspond to the present practice of acknowledged authorities. The reviser has omitted specifications for timber and has disposed of the matter by saying that timber is graded or classified at the saw mills according to the standard rules of the different manufacturers' associations, and specifications should call for a grade of timber agreeing with the classification of the mills of the region where the lumber is produced. This is a sensible remark. However, the bridge engineer would not wish to allow the manufacturer to entirely fix his grade for stringers. The author's values for unit stresses in timber are higher than standard practice allows. The expression "sand-lime brick" should be used in place of "sand brick." Few of the latter attain the strength quoted by the reviser. It is to be noted that there is no discussion of methods of testing materials or of the machines and operations of the testing laboratory. Of course matter of the kind given in this chapter will form only the starting point for a student who will obtain detail and reasons in separate courses on Metallurgy, Materials of Construction, Masonry Construction or the like. It is difficult to see the wisdom of including certain scraps of information concerning such matters as directions for obtaining voids in gravel and sand, mixing concrete and painting.

Rankine's theory of earth pressure has been taken from its former position and inserted after the theory of internal stress, where it belongs.

The condensation and simplification of the chapter on Envelopes, and the omission of the section on Standpipes, has shortened Chapter XIII. by 5½ pages. In the chapter on Plate Girders, theoretical and mathematical deductions of doubtful validity are omitted, and the result of approved practice inserted in their place.

The treatment of plates consists in the quotation of the Grashof formulas, without discussion or limitation. For the student, and indeed also (as far as we know) for the use of the practitioner, it is better to proceed, as does Merriman, to derive simple formulas from the fundamental theory of beams.

The chapter on Details in Wood and Iron has been entirely omitted, and a chapter on Reinforced Concrete has been added. The latter is well judged and simple; and contains little discussion. The computation follows the assumptions that steel takes all the tension, and at a working stress of 16,000 lbs. per sq. in.; that the stress-strain diagram of concrete in compression is rectilinear, with a working stress of 500 lbs. per sq. in. The ratio of the moduli of elasticity of steel to concrete is taken as 10 and the working adhesion between concrete and steel is quoted as 50 lbs. sq. in. It is interesting to quote what the author said in relation to this subject in the 1897 edition, written some time before any discussion took place in the technical press; and to see how nearly it corresponds with the present practice:

Beams of Cement with Iron Rods.—Plates or beams of cement are used into which a sheet of wire netting or a combination of rods of iron has been built for the purpose of increasing the tensile resistance of the com-

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bination. They are known as Monier plates. The expansion and contraction of the two materials from changes of temperature is so nearly alike that heat and cold produce no ill effects. The ultimate strength of the combination lies at the yield point of the metal; for the expansion of the iron or steel above that limit is much greater than that of the encasing cement, so that the cement breaks. Rods of square section, twisted, are used, the twisted contour increasing the hold of the iron on the cement.

The iron may be computed at not above 7,500 lbs. per sq. in. unit tension, neglecting the tensile resistance of the cement. The neutral axis, when the iron is placed at one-sixth the thickness of the plate from the tension side, should be assumed to lie at three-fourths the thickness from the same side. For mortar, one part of cement to three parts of sand, six months old, E = from 4,000,000 to 5,500,000 for the combination, a value higher than for pure cement.

The new edition has resulted in better press work, clearer diagrams and an enlargement of type for algebraic work.

A Cyclopedia of Economic Geology.

Reviewed by N. S. Shaler.*

ECONOMIC GEOLOGY OF THE UNITED STATES.—By Heinrich Ries, A. M., Ph. D., Assistant Professor of Economic Geology at Cornell University. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5½ × 8½ ins.; pp. 435; 25 plates and 97 text illustrations. $2.60 net.

The aim of the author of this book—a well-determined aim—is to give the reader in an encyclopedic way an account of the economic geology of the United States, including Alaska, but excluding our insular possessions. As the main object is to set forth the facts of occurrence and the production of minerals he has to assume that those who follow his work have some general knowledge concerning the origin, structure and accidents of rocks. He very properly limits his account as to the origin of such deposits to brief statements intended to set forth conflicts of opinion on points of practical importance. In this regard the work is very well balanced. There is enough of the ample theories to enliven the body of statistics which have to be presented without leading the student too far into the tangle; perplexing enough to those who have to deal profoundly with such matters.

Going directly at his subject matter, Dr. Ries begins his presentation with a study of American coals. In a dozen pages he gives a brief but very fair account of the origin of the deposits and of the conditions of deposition and later accidents which limit their extent. Then follows a well-compiled list of the several coal fields, nine in number, unhappily excluding those of Alaska, and the so-called lignites of Montana, Wyoming and the Dakotas. These lignites are effectively coals and cover an area of at least 60,000 square miles. They have already some economic importance and are destined to play a large part in the development of that part of the world. In his statements concerning the value of particular coal deposits, the author or the proof-reader has made some blunders showing an inattention to the well-known innate perversity of figures. Thus, in estimating the contents of the Pittsburg bed at the base of the Monongahela section, he gives the area of the deposit as 50 square miles and the average thickness as 86 ft., yet reckons the original contents of the deposit at 10,000,000 tons. On the usual basis of reckoning, the total contents of the bed when it began to be exploited, was between 20 and 30 times what is set forth on page 22. In fact, as the Pittsburg seam probably has a much greater area than is here assigned to it, the reckoning is most likely yet further out. This under-estimate would not be serious save for the fact that the author terms it "one of the most important bituminous coal beds in the world." This will be puzzling to the novice when he notes the fact that the whole of that store would supply the present American market for about ten days' consumption.

After coal, petroleum and natural gas are briefly and well-treated, then building materials, clays, limes and cements. Next in succession, salines, gypsums, fertilizers, and abrasives, followed by the usual list of minor minerals, and of mineral waters, closing with a singularly insufficient account of soils and road materials. In one chapter of but four pages these most important features of economic geology are discussed with but generalized statements of little value, though they be true enough. The statistics in this section of the book are well compiled and valuable. We note, however, an apparent numerical error with reference to the money value of the trade movement in salt, the export price of 16,446,380 barrels being given at $70,296, while the import price of 32,143,546 barrels is printed as $564,966.

The second part of the book is devoted to ore deposits; there is little to criticise and much to praise; the work is excellent compilation. In the way of minor errors may be noted the brief account of the process of dredging, in which the frequent use of the sluice for saving the gold is overlooked. So, too, the statement that the placer gold of Montana is derived from veins of Mesozoic age. The source of the gold in Alder Creek, Madison Co., Montana, originally the richest placer ground in the United States, and still extensively worked by sluice dredges, is clearly from veins in the ancient crystalines, which veins are of earlier than Carboniferous age.

The book is amply illustrated, and most of the illustrations are good. Distinctly bad are certain of the maps designed to show the distribution of mineral deposits. Thus, Fig. 45, giving the distribution of the iron ores of the United States, indicates a rich development of iron ores in western Kentucky, though such do not exist, and no production in the eastern half of the state, where for twenty years there has been a considerable output of ore from the Clinton and Oriskany horizons.

The author has rendered a service to inquirers by appending to each section treating of a particular group of materials a well-compiled, compact list of papers which they may use for further information. So far as the reviewer has been able to examine, these references, aggregating several thousand in nnmber, appear to have been very well chosen, affording a valuable and much-needed clue for the student of particular fields or subjects.

As a whole the book is excellent as it now is; with the revisions of later editions which its goodness should ensure it is likely to become a standard work.

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A Manual of Railway Engineering and Maintenance of Way.

MANUAL OF RECOMMENDED PRACTICE FOR RAILWAY ENGINEERING AND MAINTENANCE OF WAY.—Containing the Definitions, Specifications and Principles of Practice Adopted and Recommended by the American Railway Engineering and Maintenance of Way Association. Chicago: The Association (1562 Monadnock Block). Cloth; 6 × 9 ins.; pp. 175; illustrated. $3; half-morocco, $3.50.

The aim of the above-named young, but large and aggressive association has been to concentrate and systematize (and to some extent to standardize) the principles and practice of railway engineering and maintenance-of-way work, and for this purpose the administration has steadily followed the policy of directing the investigations of the several committees on consistent and systematic lines with a view to continuous and progressive work. There has been no attempt to have a committee cover its entire field in one year, or to have it present a final and conclusive report; on the contrary, the Board of Direction has recommended certain subjects each year, so that the committee will cover new ground and also have an opportunity of revising and improving its past work from time to time. The result, as a whole, has been excellent, and the reports have a balance or dignity and an authority which they would not otherwise have attained. It is true that some of the committees have not made much of the ground allotted to them; others have evaded restraint and wandered far afield so that their reports have been distinguished by quantity rather than quality, but these cases have been exceptional.

In view of the wide interest in and permanent value of the reports as a whole, it seemed advisable to present the most important and fundamental matter in more available form than that of the bulky annual volumes of "Proceedings," and at the fifth annual meeting, in March, 1904, it was decided to compile from the committee reports the matter of most importance and to publish this in book form. The first issue is now before us, and covers the work of 13 committees. Like the reports themselves it is not final or conclusive, the intention being to supplement it annually and so keep it in line with the progress of the work of the association. As it is put forth as "recommended practice," care has been taken to include only such matter as has been carefully considered by the association as a body, although this means the exclusion of much valuable matter contained in the reports. For this reason the book might seem rather weak in certain subjects upon which there has not yet been any definite action.

This being the first edition of a book which it is proposed to revise and extend each year, it will be of interest to review the subject matter of the various departments: (1) Roadway; a 20-ft. width of roadway is recommended, and also a three-fold classification of material as "solid rock, loose rock and common excavation;" the specifications for the formation of the roadway cover 11 pages. (2) Ballasting; brief specifications for different kinds of ballast are given. (3) Ties; the important feature here is the recommendation of the use of certain standard forms for records of tie renewals, life of treated ties, etc., so as to ensure uniformity in the records. (4) Rails; the "minimum" standard length is recommended as 33 ft., and specifications for Bessemer steel rails are given; these latter represent the ideas of the engineers (rather than of the manufacturers) as to how to secure good rails. (5) Track; formulas and tables for superelevation on curves are given, the tables showing a maximum of 9¾ ins. (for 70 miles an hour on 3° curves), although it is recommended that ordinarily 8 ins. should not be exceeded. Transition curves are dealt with, and for rail joints a bolt spacing of 5 ins. (with 2 13-32 ins. to end of rail) is recommended for both four-bolt and six-bolt joints. (6) Buildings; general plans for local passenger stations are given, and the requirements for a roundhouse. (7) Masonry; this includes standard specifications for cement and concrete, the former being as adopted by several other technical associations. (8) Signs, Fences and Cattleguards: smooth wire and heavier wire are recommended for fencing, and the surface cattleguard is reported as being preferable to the pit guard. (9) Signaling and Interlocking; this covers train-order signals, telegraph and controlled-manual block signals, and the arrangement of signals at interlocking plants; drawings show the lamp color arrangement for semaphore signals. (10) Records, Reports and Accounts: this covers some 40 pages and presents a set of blank forms of records and reports for the bridge department. (11) Water Service: this gives a brief series of conclusions and recommendations as to water-softening treatment. (12) Yards and Terminals: the design and arrangement of yards, freight houses, coal and freight piers form the principal matter in this report. (13) Iron and Steel Structures: the recommendations include the furnishing of plans and specifications by the railway and the making of bids on a pound price basis; where bridges have to be erected under traffic it is recommended that the railway company should do the work. General specifications for materials and workmanship of steel structures are also given.

The book is well and clearly printed and the only objection which occurs to us is that the price seems somewhat high in view of the preliminary and tentative (and in some respects incomplete) character of the contents.

NEW YORK STATE MUSEUM.—Frederick J. H. Merrill, Director. 23d Report of the State Geologist, 1903. Reprinted from the 57th Annual Report of the New York State Museum. Albany, N. Y.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 203; six plates (one in pocket) and one text figure. 45 cts.

The greater part of this report is occupied by papers on "Peat," including its uses; the "Gypsum Industry" and "Abrasives" in New York State. The first two papers are by Arthur L. Parsons, and the last one by Harry C. Magnus.

Text-Books on Descriptive Geometry.

Reviewed by Henry S. Jacoby.*

ELEMENTS OF DESCRIPTIVE GEOMETRY.—With Applications to Isometric Projection and Other Forms of One-Place Projection. A Text-Book for Colleges and Engineering Schools. By O. E. Randall, Ph. D., Professor of Mechanical Drawing, Brown University. Boston and New York: Ginn & Co. Cloth; 6¾ × 9½ ins.; pp. 209; 193 figures in the text. $1.50.

ELEMENTS OF DESCRIPTIVE GEOMETRY.—By Charles E. Ferris, Professor of Mechanical Engineering, University of Tennessee. New York: American Book Co. Cloth; 6 × 9½ ins.; pp. 127; 113 figures in the text. $1.25.

ELEMENTARY DESCRIPTIVE GEOMETRY.—By C. H. McLeod, McGill University, Montreal. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¼ × 8¼ ins.; pp. 118; 85 figures in the text. $1.50.

NUMERICAL PROBLEMS IN DESCRIPTIVE GEOMETRY.—For Class and Drawing Room Practice. By G. M. Bartlett, M. A., Instructor in Descriptive Geometry and Drawing in the University of Michigan. Published by the Author. Paper; 5¼ × 7½ ins.; pp. 62; 17 figures in the text. 50 cts.

The publication in this country of seven books upon Descriptive Geometry during the past three years indicates a widespread interest in the method of teaching this subject in engineering colleges, and also that no substitute for a text-book is considered satisfactory by the majority of teachers. Three of the seven books have already been reviewed in this Supplement,† while the titles of the other four volumes are given above.

The 18 chapters in Randall's book include the following groups of topics: Definitions, notations and the representations of point, line and plane, 35 pages; problems relating to the point, line and plane, 38 pages; generation and classification of curves and surfaces, and the representation of surfaces, 48 pages; determination of planes tangent to surfaces, 31 pages; intersection of surfaces and development, 40 pages; isometric and cabinet projection, and pseudo-perspective, 17 pages.

The feature that first attracts attention in examining this work is the generous space devoted to a full explanation of the fundamental principles and methods that are so important to the subsequent progress of the student. The use of numerous illustrations and problems given in this part cannot fail to give clear conceptions at the very beginning of the course. Much of the difficulty encountered by students of descriptive geometry is not due primarily to its demands upon the undeveloped imagination but rather to the inadequate treatment of these fundamental elements to be found in most text-books. It is not enough to state a lot of definitions and principles; they must be fixed in mind by means of problems before proceeding to take up the numerous relations of points, lines and planes. For this purpose the student should find these problems in the text-book to aid him in his lesson study. The value of many of the problems given by Randall is enhanced by having the data definitely located.

The second noteworthy feature is the representation of the objects in the third angle in order to conform to the prevailing practice in the mechanical shops. Third-angle projection was previously used in four books, the latest two, those of Moyer and Ferris, being published in 1904. The fact that this method was adopted in three books published in direct succession seems to show a definite tendency.

The notation employed is the older form given by Church, except that the horizontal projection of a point has an accent mark added as a subscript to the lower case letter. It seems that this arrangement must require special care by the student to avoid confusion, since the vertical projections are designated by the addition of an accent or prime. It is to be regretted that the author did not adopt the more natural modern notation introduced by Watson.

The representation of surfaces includes one chapter of 12 pages on warped surfaces, including the hyperbolic paraboloid, the hyperboloid of one nappe, the helicoid, the conoid, and a few general forms. The rest of the contents cover satisfactorily all the examples usually included in the corresponding portions of the larger text-books. The text reveals especial care in its preparation. The statement of a problem is followed by an analysis before giving the details of the construction. A large number of problems to be solved by the student are given throughout the book. The lack of an index should be supplied in a later edition.

The work of Ferris has the same title as that of Randall, and contains practically all of its good qualities, as described above. The subjects treated by Randall in 192 pages are covered by Ferris in 102 pages. The condensation is secured mainly in the portions on the representation of single and double-curved surfaces and on intersections and development. The text is clear and concise, the treatment of each problem is subdivided into a "solution" or analysis and the construction, while a number of well-selected examples to be solved by the student are contained in each chapter. The chapter divisions are particularly good.

The book contains in addition two very short but well-written chapters on shades and shadows and on perspective. The last chapter, however, would be materially improved by inserting a brief description and illustration of the general method of measuring a line of any direction by means of an initial trace and of the point of distance for the given direction. The experience of the reviewer leads him to the conviction that the principles and methods may best be fixed in mind by constructing in perspective some of the problems given in the chapter on the relations of the point, line and plane. This is especially true when the time devoted to perspective is necessarily very short. The book also lacks an index.

A comparison of the illustrations in the books of Randall and Ferris shows the decided advantage of the modern notation adopted by Ferris, since both use third-angle projection. The subscripts h and v leave no doubt on which plane a point is projected, no matter on which side of the ground line the projection may lie. It is to be regretted, however, that the author did not adopt entirely the notation of Watson. The designation of a plane, for instance, by $R_h R R_v$, seems to be a cross between the notations of Watson and Church, and introduces an element of inconsistency.

Both of the books described are excellent examples of book making, in which the clear and relatively thin paper is as important as the fine presswork. The lettering on the illustrations is in harmony with the text, as italics are used for both capitals and lower-case letters. In their physical make-up and low cost, they are the best books on descriptive geometry yet published.

There is a tendency in some quarters to cut down the course in descriptive geometry to its lowest limits without eliminating it from the curriculum of engineering colleges. The introduction of new technical courses is partly responsible for this crowding. McLeod's Elementary Descriptive Geometry is apparently written in view of this tendency, for the author, in his concise preface of 13 lines, states that the object of the book is to put into concise form what he considers the minimum requirement of knowledge of the subject for students entering an engineering course. The book covers the same general topics as Randall's, with the exception of warped surfaces, and after adding a chapter of four pages on shades and shadows the text occupies only about 40% of the space devoted to it by Randall. In this narrow compass, however, the author treats 75 problems and gives 69 examples for students to solve. The treatment of a problem combines in a single statement the analysis and details of construction, and therefore loses the pedagogic value of the analysis. First-angle projection and Church's notation are employed.

The chapter on the projection of solids with plane faces deserves particular mention, both because of the objects selected for representation and for the practical methods employed in constructing the projections. The same methods are also applied to the cylinder and the cone. This is a distinctive feature not found in any other text-book on the subject.

The pamphlet by Bartlett is intended to accompany a text-book, and furnishes 482 numerical problems on the point, line, plane, surfaces, tangency and intersections; on the graphic solution of spherical triangles, and on the determination of the skew angles in roof structures. Every teacher who wants to secure efficiency in his class recitations and drafting room work must prepare a large number of such numerical problems, and in proportion to the labor put into the preparation of this published collection may the labor of others be saved by their use. Church's notation is employed. Previous lists of problems like those of Waldo, were given without numerical data, and hence lacked an important element of value that had to be supplied by the instructor.

A few brief paragraphs will now be devoted to a general consideration of the various text-books on Descriptive Geometry, including all such books known to be in use at the present time.

The use of third-angle projection was first published in 1893 by W. L. Ames, in his Notes on Descriptive Geometry, after their use for four years in his classes. It appeared next (1896) in Theoretical and Practical Graphics, by F. N. Willson, being used in the projection of solids and in the intersection and development of surfaces, thus repeating a part of the course in descriptive geometry contained in that work and that is presented in first-angle projection. The remaining books containing the third-angle method are those of Moyer, Ferris and Randall, referred to in the preceding reviews.

The notation adopted by Church in 1864 is also used by Waldo and MacCord, and in modified form by Willson, Randall and McLeod. Watson's notation was followed by Faunce and Hall, and in modified form by Ames, Moyer and Ferris, while Woolf employed Watson's notation for planes and a modification of Church's notation for points.

Warped surfaces are included by Church, Watson, MacCord, Willson, Hall, Ferris and Randall, and in part only by Waldo, Woolf and Ames. The most elaborate treatment is given by MacCord and Willson. Shades and shadows are included by Church, Willson, Ferris and McLeod, the last two treating the subject very briefly. Perspective is added by Church, Willson and Ferris, while Hall gives merely a brief reference to it. For any adequate and modern treatment of perspective it is necessary to consult books especially devoted to the subject, either alone or in combination with shades and shadows.

The topics from points, lines and planes to intersection and development, inclusive, are treated by all the text-books more or less extensively. The greatest difference relates to first principles and methods, and to these the most attention is given by Woolf, MacCord, Ferris and Randall. The works of Church, Watson and Hall consist of two volumes each, one of text and the other of plates. Watson's plates include a set of stereoscopic diagrams. The books that may be fairly classed as text-books, published in single volumes and arranged in the order of space devoted to the combined text and illustrations, are those of MacCord, Randall, Willson, Woolf, Ferris, Moyer, McLeod and Faunce.

CONVICT LABOR FOR ROAD IMPROVEMENT.—Bulletin No. 5, Highway Department, State of Ohio. By Sam Huston, Commissioner. Columbus, O.: Pub. Doc. Paper; 6¼ × 9½ ins.; pp. 35.

Notes by Mr. Huston on personal inspections of Southern convict labor gangs and camps and on interviews with Southern men in various walks of life are followed by extracts from State legislation on the subject. The author presents no summary of facts or conclusions, but evidently he was unfavorably impressed by what he saw and heard of convict gangs and camps. Of the character of the work accomplished by convicts he seems to have a better opinion.

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†Descriptive Geometry. By Wm. S. Hall. New York: D. Van Nostrand Co. $3.50 net. Reviewed March 19, 1903.
Notes on Descriptive Geometry. By J. C. L. Fish. Palo Alto, Cal.: The Author. $1.75. Reviewed June 18, 1903.
Descriptive Geometry. By James A. Moyer. New York: John Wiley & Co. $2. Reviewed May 18, 1905.

Radio-Activity.

Reviewed by Charles Baskerville.*

RADIO-ACTIVITY.—By E. Rutherford, D. Sc., F. R. S., F. R. S. C., MacDonald Professor of Physics, McGill University, Montreal, Canada. Second Edition. Cambridge: The University Press. New York: The Macmillan Co. Cloth; 5½ × 8¾ ins.; pp. 580; 108 figures, mostly in the text. 12s. 6d., net; American price, $3.50, net.

The first edition of this modern scientific classic (reviewed in this journal June 15, 1905, p. 641) contained 399 pages. The book has grown in one revision to 580 pages. The growth is fully justified, so great has been the progress in our knowledge of these new phenomena, to which the author has made the most valuable contributions. No words are wasted. The terse diction of the masterpiece gives it a literary charm that carries the competent reader on almost precipitously, yet with discriminating caution.

It is not a popular work. It is not easy reading to the layman; it is not intended for him. It has a spaciousness of active scientific thought which reaches far into the unknown. Authentic, it is rich in suggestions to the investigator, be he chemist, physicist, engineer, or physiologist. It quite properly dismisses the biological action of radium and radio-active preparations and their applications for such purposes in a few pages.†

The discovery of the emanation by Rutherford, important as it was, was a comparatively simple matter to the subsequent elucidation of the changes radium and its products undergo. To the latter work the author has given tremendous energy of late, in spite of the trying demands upon his time for lectures and addresses on both sides of the Atlantic.

The passage in detailed review of the contents of this book would draw too heavily upon these columns. The reviewer must content himself with calling attention only to a few of the general problems involved. A critical study of the work cannot but prove profitable to every chemist and physicist. Additions have been made to certain chapters, while others have been in part or wholly rewritten. The reader is acceptably advised of these particulars by specification on the page where the table of contents is presented.

Rutherford gives full credit to other investigators and a just recital of the views of those who happen to hold different ideas as to the true explanation of these new phenomena. Yet every argument so far obtained is presented to substantiate the ideas of the disintegration of the atom. The theory of disintegration need not be recounted here. The reviewer, holding some conceptions of his own, frankly acknowledges that the burden of experimental evidence supports Rutherford's hypothesis. Reviews should not assume a controversial character, however.

The theory of disintegration has been so injudiciously quoted and so misapplied by some formal, as well as lay, writers, that it may be well to quote the words of the careful savant, who has given us the explanation: "the continuous emission of energy from the radio-active bodies is derived from the internal energy inherent in the atom, and does not in any way contradict the law of the conservation of energy." Yet we are informed that the emanation of radium in breaking up gives out three million times as much energy as is observed by the explosion of an equal amount of hydrogen and oxygen in the proportion to form water. More heat is produced by this than in any known chemical reaction.

The amount of radium emanation in the atmosphere has been determined. It has been learned that one cubic kilometer of air contains the emanation which is supplied by 0.56-gram of radium bromide. The total to be had from the world's air is equivalent to 400 tons of radium bromide. Without bringing into consideration the mathematical calculations, it may be said such data indicate that the life of the earth may be extended fifty million years beyond the calculations of Lord Kelvin.

The fact that the phosphorescent light from radium bromide shows a bright line spectrum of nitrogen, when that gas is present, indicates that radium is able to set up radiations which are produced only by an electric discharge under special conditions.

The alpha and beta-rays are definitely spoken of as particles. This takes J. J. Thomson's electron explanation in its entirety. No definite proof was had for a long time as to the loss of weight of a radium preparation.* It has been determined that one gram of pure radium bromide loses 0.5 mgm. a year, as alpha-particles and 10^{-9} grams in the same period as beta-rays. The electron or corpuscle is the body of the smallest mass known to science. The *kanalstrahlen*, with positive electric charge, appear to be associated with bodies atomic in size. The process of ionization in gases is supposed to consist of the expulsion of an electron (with negative charge) from the atom. The corresponding positive electricity remains behind on the atom and moves with it. It has been determined that "the charged ion, responsible for the radiation from a luminous body, is identical with the electron set free in a vacuum tube." From this a general conclusion, which has cropped up many is the time in the history of chemistry, has arisen, to wit: all atoms are built up of electrons, the apparent mass of which is very small compared to the hydrogen atom. This reminds us of the suggestion of Zangerle, who elaborated the hypothesis of Prout as modified by Dumas. In the light of such speculations and the renewed activity in promoting their acceptance, we must again quote from our author, who is conservative in his pioneering: "While the experimental results have led to the view that the constitution of the atom itself is very complex, at the same time they have confirmed the old theory of the discontinuous or atomic structure of matter." Thus we may abide awhile longer with Dalton's ideas, which have regulated chemical thought for a century. It is not rank heresy to feel in the air at this time symptoms of other, perhaps newer, and truly more sweeping generalizations!

The nomenclature has been changed (p. 329). The phases of the disintegration of the emanation are designated "Radium A, Radium B," etc. On reading of these changes, which are based not alone upon physical grounds, but chemical conduct as well, one readily appreciates the wisdom in the selection and suitableness of the elastic nomenclature.

Not a few radio-active elements have been announced, such as polonium, radio-tellurium, emanium, etc. From Rutherford's work it now appears that "Radium F," which gives out only alpha-rays, is the polonium of Madame Curie and Marckwald's radio-tellurium. The radio-lead of Hoffmann contains "Radium D, E, and F." All of these are had from pitchblende, from which radium is extracted. The "Radium D, E, and F" in pitchblende may be separated by chemical means. In fact, such general statements may be made as: "All radio-elements differ from radium only in the slowness of their change," and there is a possibility of the reduction of radio-active substances to a unit.

It appears that uranium is the parent of radium. It is half-transformed in 6×10^9 years. Radium and Radium D are half-transformed in 1,300 and 40 years, respectively. A mineral which contains one ton of uranium may have a content of 1.8 g. of radium and 0.063 of Radium D.

In an appendix is presented some very recent unpublished work. A "rayless" change has been observed in the disintegration of the atom. This doubly paradoxical statement, without elucidation, is staggering. We know of radio-activity by reason of rays, with their characteristic behavior. The "rayless" condition is temporary, as it were: a wayside inn for momentary relaxation from the strenuous course pursued by these bundles of energy. The atom by definition cannot be divided. If the emanation be breaking up, and it is, then by definition it cannot be an atom. Frankly, the selection of another term would have been more desirable. However, such does not seriously interfere with our acceptance of the ideas of Larmor, Lorentz, and others, concerning the heavy chemical elements, which may be looked upon as having a complicated structure consisting of charged particles in rapid oscillatory or orbital motion in regard to each other.

"Rayless changes" clears a fertile field for the imagination. It suggests that "ordinary matter may be undergoing transformations accompanied by the expulsion of alpha-particles at a rate much greater than that shown by uranium, without producing appreciable electrical or photographic action."

Whither are we bound? It matters not. Take the goods the gods provide and be happy.

*Professor of Chemistry and Director of the Chemical Laboratory, College of the City of New York, New York City.

†That phase of the subject has been dealt with rather fully in a book by the writer of this review.

THE COST OF SHELTER.—By Ellen H. Richards, Instructor in Sanitary Chemistry, Massachusetts Institute of Technology. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5 × 7½ ins.; pp. 136; illustrated. $1.

Not long ago Mrs. Richards, who is well known to many of our readers as a sanitary chemist, published an interesting and suggestive little book on "The Cost of Living, as Modified by Sanitary Science." Subsequently she expanded some of the ideas into a companion volume entitled "The Cost of Food." Now we have a third volume, in the same general line, which contains many points that will appeal to any thoughtful person and some that will appeal strongly to engineers.

After dwelling upon the house in its relation to family life, as a measure of social standing, and as a legacy of the nineteenth century ill-adapted to the need of the twentieth century, some of the "possibilities in sight provided the housewife is progressive" are considered. These topics lead up to a discussion of the cost of different grades of shelter per person and per family and of the relation between cost of shelter and total income. In conclusion, the "difficult question," whether "to rent or to own," is considered.

The author rightly holds that the housing question has not yet been approached in the spirit of modern progress. In both capital and operating charges, shelter makes too heavy a demand upon all classes with incomes of between $1,000 and $5,000. Labor-preventing and labor-saving devices are to a great extent ignored, but will be a feature, it is to be hoped, of the house and house equipment of not many years hence.

Due emphasis is laid, at several points, upon the cramped quarters and scarcity of air and light resulting from the increased cost of housing. The block plan of houses, with central heating and other service, located in the country, is suggested as one means of providing ampler quarters.

At times, in fact more frequently than one would expect, the author's own ideas seem vague—not clearly worked out to a conclusion and not modified by the present and reasonably prospective status of the industrial arts. There is some excuse for the inconclusiveness of parts of the discussion, but little or none for such scientific vagaries and confusing language as the following:

> Heating might now be acomplished without dust and ashes, without the destructive effects of steam, if enough houses would take electricity to enable a company to supply it in the form of a sort of dado carrying wires safely embedded in a non-conducting substance, or in the form of a carpet threaded with conducting wire.

When electric heating becomes an economic possibility, householders will "take electricity" for that purpose as readily as they now do for lighting, but they will not take it "in the form of a sort of dado."

Although such misleading statements are unfortunate, they do not detract greatly from the main value of the book, which is to direct attention to an important and sadly neglected phase of sociology and economics. Since the solution of many of the detailed problems presented will fall upon the engineer and the architect, we take pleasure in commending the book to their attention—both professionally and as men deeply concerned in the uplift of the race.

Turbines and Water Power.—Die Dampfturbine.

Reviewed by Storm Bull.*

MODERN TURBINE PRACTICE AND WATER-POWER PLANTS.—By John Wolf Thurso. New York: D. Van Nostrand Co. Cloth; 6 × 9½ ins.; pp. xxii. + 244; 89 illustrations, mostly in the text. $4 net.

DIE DAMPFTURBINE.—A Text-book and Handbook for Designers and Students. By Wilh. H. Eyermann. Munich and Berlin, Germany: R. Oldenbourg. Cloth; 6½ × 9½ ins.; pp. 212; six plates (one in pocket) and 153 text illustrations. 9 marks; American price, $3.60.

Mr. Thurso's book is a distinct addition to the best literature on turbines and water power in the English language; in fact, the reviewer is of the opinion that there is no other English book which covers the subjects treated in Thurso's book. In the preface it is stated that

> the object of the book is to give such information in regard to modern turbines and their proper installation as is necessary to the hydraulic engineer in designing a water-power plant, and no attempt has been made to treat on the design of turbines, as to do this satisfactorily would require in itself a very large volume.

Such information the author certainly gives in his book; but he is almost too modest when he claims that he has not attempted to treat on the design of turbines; he has in his book some eighty excellent illustrations of details of turbines and of whole installations, which will be very useful to all designers of turbines. The author's comments on these illustrations will also contribute to the same end.

The book is divided into nine chapters and an appendix, besides which there is an introduction in the form of a very full definition and explanation of all symbols and terms used in the book. The author is to be commended for having used both uniform and logical symbols throughout the book. The study and understanding of the subject treated is very much facilitated because of this practice.

The first two chapters treat of turbine practice in Europe and America respectively. It is evident from the reading of these two chapters that the author is thoroughly conversant with his subject, and, to the reviewer at least, it is not surprising that he comes to the conclusion that the American manufacturers of turbines have been distanced by their European competitors—except perhaps as to turbines for low heads. It is somewhat humiliating to have to acknowledge this; but facts seem to show it conclusively. Mr. Thurso points out the defects in American practice so plainly that the book should serve as an incentive to American manufacturers to improve their design.

The third chapter takes up the classification of turbines. It seems to the reviewer that the author very clearly and simply shows the difference between the various classes. The fundamental rules of design for the different classes, as well as their advantages and disadvantages, are also given. Like most authors, Mr. Thurso uses the terms "reaction" and "action" turbines, which terms, as the reviewer has pointed out in another place, do not really mean anything. All turbines work with reaction, and consequently no one turbine should be called a "reaction" turbine in preference to another. The reviewer has proposed the terms "pressure" and "velocity" turbines.

In this connection attention might also be called to the fact that the author distinguishes between the inward flow turbine, as built in Europe, and the ordinary American turbine, which he calls the vortex type. There does not seem to be a good reason for giving these a special name, since both the European inward flow turbine and the American turbine are modifications of the original Francis turbine, and since the only differences between the two at the present time are that in the European turbine the water is not made to turn quite so much as in the American, that the diameter of this latter is smaller than that of the former for the same amount of water and head, and that perhaps the European turbine is designed somewhat more carefully.

A short discussion of the steam turbine is given in Chapter IV. There does not seem to be sufficient reason for including this chapter in the book. It is perfectly true that there is a very close relation between steam and water turbines, but the differences are also very great, and a short discussion of such a difficult subject as the steam turbine is of very questionable value, especially in a book written—as stated in the preface—to give information to hydraulic engineers for the installation of water-power plants.

Chapter V. treats of "Modern Turbine Types and their Construction." Here will be found a large number of illustrations of some of the very best turbines installed during the last few years. In commenting on and explaining these turbines the author shows his thorough familiarity with the subject. Although the author states in his preface that the "American standard type of turbines has not been shown in the illustrations, as every hydraulic power-engineer is familiar with it through the engineering press and the turbine catalogs," the reviewer is of the opinion that it would have increased the usefulness of the book if a few illustrations of the standard American turbine had been included in the book.

In Chapter VI., "Accessories to Turbines," the most important topic discussed is the draft-tube. The treatment is excellent, and is certainly the most complete one to be found in the English language. Chapter VII. treats of governors and speed regulation and contains descriptions and illustrations of the most important American and European types. The critical discussion of the various makes is very useful. In Chap. VIII. the author takes up the general subject of water conductors, treating it under the following heads: Headrace and tailrace; water-racks; head-gates; penstocks. In no other part of the book, except in the last chapter, does the large practical experience of the author appear so fully. He gives here a very large amount of information which ought to be of value to every hydraulic engineer.

The final chapter treats of the development of water power under the following heads: Developing a water power; surface, anchor and frazil ice; measurement of water for selling water-power; and cost of water power. Here again the practicing engineer should be able to greatly profit by a close study of the various topics. The appendix contains a paper by A. K. Garrat, reprinted from the Institute of Electrical Engineers, on the regulation of speed in water-power plants.

The book as a whole is clearly and concisely written, and seems to be remarkably free from errors. However, when the author says, in a letter forwarded to the reviewer, that the size of the book has been kept down in order that the price might be made low so as to insure a large circulation, it is not out of place to state that $4 is not a low price for a book of 266 pages, all told; but evidently the discrepancy is not the fault of the author. The typographical execution of the book is all that could be desired. The book deserves the widest circulation among all classes of engineers.

Mr. Eyermann's book on the important subject of steam turbines is of an essentially different character from that of Stodola, the several editions of which have been reviewed in these columns (Jan. 14 and Aug. 18, 1904, July, 13, 1905; translation, May 18, 1905). It is a great deal more elementary than the latter, and this with the evident intention of making it more accessible to the average practicing engineer. Mr. Eyermann has been eminently successful in this endeavor. Evidently he had to sacrifice some of the extreme thoroughness, because of mathematical and other difficulties, which characterizes Stodola's book, but notwithstanding this the treatment seems very satisfactory. The book is very well arranged; in fact, a great deal better than Stodola's, this latter showing too clearly that it had been "expanded" various times. The book is also very clearly written. It is even difficult to find any samples of the traditional involved German, so that persons with a fair knowledge of the language ought to be able to read this book without difficulty.

Although Eyermann's book is comparatively elementary, yet a knowledge of differential and integral calculus is required to understa[nd] it. But it should be added that it seems to b[e] possible to give a satisfactory theory of the [tur]bine without the use of higher mathema[tics].

A very valuable feature of the book is the [la]rge number of solved numerical examples. Such [con]crete examples will certainly be very we[lcome] both to the practicing engineer and the stu[dent]. In this connection it should be added th[at] author uses graphical methods to a very [large] extent, and, it would seem, with great su[ccess]. The book contains a number of diagrams to [illus]tate such graphical computations, among [them] the modified temperature-entropy diagram [of] Professor Mollier.

Because of the shortness of the theoretical [de]velopments a very large part of the book could be given over to practical questions, and it is evident from the reading of this portion that the author is familiar with his subject. The various kinds of turbines are discussed in this part of the book and their descriptions are accompanied with excellent illustrations, both of whole installations and of some of their details. The book is very well gotten up, the paper, as usual in German books, being of exceptionally fine quality.

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ESCAPEMENTS.—Historical Development, Construction, Repair. Vol. I. of Watchmakers' Library. By C. Dietzschold, M. E., Director of the Austrian Watchmakers' Academy. Krems a D., Austria: The Author. Boards; 6 × 9 ins.; pp. 234; 84 illustrations in the text and numerous tables.

"Practical and theoretical, for watchmakers and engineers," is the purposed character of this work, not only of the present but also of the succeeding volumes. This would include historical sketch, outline and study of function, description of actual types, theoretical study of action and design. In the volume before us, each of these essentials is represented in some manner, but unfortunately neither arrangement nor thoroughness are such as to make the book worthy the name of treatise. We judge in this from the standpoint of the engineer, and it is possible that the watchmaker would find the work more satisfactory. Judging further from the engineer's standpoint, the work loses by separating escapement and regulator. In one sense this is proper, since in the matter of type they are independent variables: fundamentally, nearly any form of escapement could be used with either balance or pendulum regulator (excepting from this statement such specialized designs as the free lever escapement, now universally used in watches). But the analytical study of the control mechanism and of its interaction with the drive can be made only by considering regulator and escapement together, and is impossible in separate consideration of the escapement. It necessarily follows that the author's rules and tables for design are purely empirical, and that the analytical side is virtually unrepresented. In the way of historical and descriptive material there is much in the book, though not always good in treatment and arrangement. A fair idea may be formed, by the careful reader, of the development of escapements, and of the meritorious work of Huyghens, Hooke, Graham, Harrison, Mudge, Lechot, Arnold, Dennison and other brilliant workers to whom our modern wonderful facilities for measuring time are due. It is highly desirable that the literature of mechanical engineering should contain a full treatment, descriptive and analytical, of the miniature precision machine, the clock; the present work does not supply it.

U. S. COAST AND GEODETIC SURVEY.—Report of the Superintendent, Showing the Progress of the Work from July 1, 1904, to June 30, 1905. Washington, D. C.: Pub. Doc. Cloth; 9 × 11¼ ins.; pp. 347; folding and other plates, and four sketches in pocket.

Besides general and detailed reviews of the work of the year, including an account of precise leveling from Red Desert, Wyo., to Seattle, Wash., this volume includes a brief description of a "Long Wire Sweep," for bottom surveys of harbors and anchorages, and also "A Plane Table Manual," both by D. B. Wainwright. The "Manual" comprises about fifty pages of text and a number of plates of topographical signs and maps.

Cement Testing.

PRACTICAL CEMENT TESTING.—By W. Purves Taylor, M. Sc., C. E., Engineer-in-Charge Philadelphia Municipal Testing Laboratories. New York: The Myron C. Clark Publishing Co. Cloth; 6 × 9¼ ins.; pp. 320; 142 figures, mostly in the text, and 58 tables. $3 net, postpaid.

This book purposes to cover a new field in the literature of cement testing. To the author's mind all previous books on cements, when discussing testing, are of little real assistance in enabling either the novice or the expert to increase the accuracy or simplify the routine of his work. The reviewer will be frank in stating at the outset that he is in a large measure in full agreement with the author's contentions.

In the best books on cement, and there are several excellent ones, the chapters on testing, unless supplemented by personal or other directions, fail to supply the tyro with detailed rules or instructions which can be followed with reasonable certainty of success. To the more experienced operator, who is on the lookout for suggestions as to laboratory organization, equipment and record-keeping that will increase the accuracy and efficiency of his work, these chapters are of even less value in the particular named. It is not believed that these assertions will be generally disputed even by the authors of cement books. Indeed, it is not to be expected that a treatise on cements and cement products for the general practitioner shall be a handbook of laboratory instructions for the cement tester. While this is true, it is also true that such a handbook, or some approximation to it, is needed by engineers, and this, it may be presumed, is why the author of the present work has sought print for his book, an outline of whose contents and character will now be given.

With the exception of the chapter on "Classification and Statistics" and the one on "Cement Manufacture," comprising together barely 30 pages, the entire book is devoted to the discussion and description of methods of cement testing. The tests considered are those employed in ordinary routine work to determine whether a particular shipment of cement is of a quality sufficiently good for construction work. Research or experimental tests are only incidentally considered. The book, therefore, is designed for the practicing engineer and builder, and not for the scientific investigator. This is, of course, what should be expected from the author's training and position as the head of a practical cement testing laboratory of a large municipal public works department. It is not beside the subject to note, moreover, that the Philadelphia Testing Laboratory is one of the oldest of such laboratories in America, and in its particular specialty of cement testing occupies an enviable position for the scientific accuracy and practical efficiency of its work.

The author commences the distinctive subject matter of his book with a discussion of "Inspection and Sampling." The ordinary methods of shipping cement are described and directions are given for preventing rebagging inferior cement and the return of rejected material to the work. Methods of storage are briefly described. The preliminary inspection should determine the general condition of the shipment; directions are given as to the items to be determined and as to what defects may be considered a reasonable cause for rejection. The selection of samples for future testing is considered at length, the number of samples to be taken is stated for different circumstances, and the method of securing the samples, of transporting them to the laboratory and of storing them in the laboratory, with the various apparatus required, are described.

Coming now to the testing methods proper, the author describes first and briefly the purpose of routine tests and defines the requisites for accurate and efficient testing work. The chapters which follow describe in order tests for specific gravity, fineness, time of setting, tensile strength and soundness. It is beyond the limits of the space available to consider each chapter in detail, but, as the scheme of discussion is the same in all, its explanation will suffice fairly well to show the character and quality of the information presented. In brief, then, the author first defines the test and explains its purpose; he follows this with a statement of the various conditions affecting the property being determined, as, for example, the effect on time of setting of composition, age, character of mixing water, fineness, temperature and dampness. The manner of mixing and molding or otherwise preparing the test specimen is then described in detail, the successive manipulations being taken in order and described with the apparatus used. The actual test act—sieving, breaking etc.—is then described in detail, with the apparatus used, and finally the various sources of error are cited and explained and instructions are given for the interpretation of the results.

Following the elaborate discussion of soundness tests, there is a chapter on chemical analysis which gives full directions for complete chemical analysis, alternative short methods for control work, directions for detecting adulterants, etc. A chapter on special tests includes transverse tests, adhesion tests, shearing tests, abrasion tests and porosity tests. A chapter on approximate tests gives methods of testing cement where no apparatus or only such as can be made by hand is available.

Chapter XIV. discusses the equipment, organization and practical operation of a cement testing laboratory. The list of apparatus needed, the cost of operation and systems for recording the work done are explained. In Chapter XV. the author describes methods of testing natural slag and other cements than Portland. A closing chapter discusses specifications for cement and is followed by appendixes giving various standard cement specifications. This section of the book is unusually valuable. It is hardly necessary to add, after the preceding outline and comments, that Mr. Taylor has produced a unique book, which promises to be of great value to cement testers and to all others interested in seeing that cement conforms with the best standards of the day.

DES INGENIEURS TACHENBUCH.—Published by the Society "Hütte." Nineteenth Edition, enlarged. In Two Parts. Berlin, Germany: Wilhelm Ernst & Son. Cloth; 4½ × 7¼ ins.; pp. (Part I.) 1,334, (Part II.) 926; many illustrations in the text. 16 marks; American price, $6.40.

In its present, or nineteenth, edition this work continues to stand forth worthily as the best handbook (it is hardly fair to use the term "pocket-book" for a two-volume affair measuring 5¼ × 7¼ × 3¼ ins., or 124 cu. ins., although the title of the work gives it that name) which is available to engineers in any language. It gives a condensed account, theoretical and descriptive, of practically every field of strictly engineering activity, including, what is remarkable, a section on ship work. The depth of treatment varies enormously, of course. Railways and bridges, for example, are treated at great length, while surveying is almost shabbily handled. But such criticisms are quite captious. A more appropriate criticism may be directed against the size of the work, which in the revision for this edition has further gained to the extent of 200 pages. To convert a handbook into an encyclopedia is not in the proper order of things, yet that risk appears imminent in the case of the "Hütte." It is only too true that there is a large number of engineers and semi-technical men who are eternally seeking for a one-volume compendium of all engineering science and technic. The makers of books intended to serve mainly the working engineer are not rarely misled into compromising with this unreasonable demand, and it would seem that at least a shadow of this effect fell across the "Hütte." But whatever practical truth may lie in this remark, the reader and user of this manual cannot fail to constantly admire and feel grateful for the merits of the work, the precise learning and full experience laid down in it, the careful editing and the excellent mechanical make-up. On top of all, the selling price of the work, when compared with American book prices, must be adjudged nothing short of marvelous.

PHYSICS.—By Charles Riborg Mann, The University of Chicago, and George Ransom Twiss, The Central High School, Cleveland. Chicago: Scott, Foresman & Co. Cloth; 5¼ × 8 ins.; pp. 453; eight plates and 237 text illustrations. $1.25.

The publication of this book marks a slight departure from some of the generally adopted methods in writing elementary books on Physics. It is quite generally conceded, as is set forth in the author's preface, that the study of physics is becoming less and less popular among academic and high school students, and that this decrease in popularity even reaches into the collegiate courses. Not even the natural interest which the boy or girl has in physical phenomena seems sufficient to arouse the real enthusiasm in the pursuit of the subject, so necessary for the mastery of its principles. According to the author, this may be attributed to the abstract mathematical manner in which most text-books on the subject are treated. The book in question departs from this method and adopts a decidedly informal style, using physical rather than mathematical arguments. Instead of approaching each new subject with a series of definitions which cannot be grasped without further enlightenment, the interrogative style is adopted, and some familiar concrete examples are given, illustrative of the laws in question. The aim is evidently to arouse the student's interest in the subject and thus create a demand for further investigation. Most noticeable is the omission of some of the familiar mathematical equations and formulas, and the substitution of physical and graphical demonstrations. Vector diagrams are used and so explained that a knoweldge of trigonometry or analytical geometry is unnecessary. While some of the familiar subjects omitted were more confusing than otherwise, it is the opinion of the reviewer that such important subjects as pulleys, wheatstone bridge, electrostatic machine, distillation, etc., should not either be thrown out entirely or relegated to the problems at the end of the chapter, as they are in this treatise. Several new chapters appear on modern theories and inventions. The free use of half-tones to give emphasis and increased interest to the concrete examples presented by the author is commendatory, except that in a number of instances it is carried to a ridiculous extreme.

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PRACTICAL SANITARY SCIENCE.—A Handbook for the Public Health Laboratory. By David Sommerville, B. A., M. D., D. P. H. (Camb.), M. R. C. P. (Lond.), Lecturer in Public Health, King's College, London. New York: William Wood & Co. Cloth; 5½ × 8½ ins.; pp. 310; 92 figures in the text. $3, net.

OUTLINES OF PRACTICAL HYGIENE.—By C. Gilman Currier, M. D., Assoc. Am. Soc. C. E. Fifth Edition, revised and enlarged. New York: E. B. Treat & Co. Cloth; 5½ × 8¼ ins.; pp. 488; 86 figures in the text. $2.

In general convenience of form, in completeness, conciseness and arrangement of matter, and in lowness of price, Whitelegge and Newmann's "Hygiene and Public Health" is unexcelled by any book on the subject. Although written primarily for British readers and students, a large percentage of its contents are of world-wide application. Much of the exposition of English law and practice is of no direct use outside of England and Wales except in the way of general information and of suggestion, in both of which particulars the review named is of great value.

The first edition of this book was published in 1890, and the preface to the present (tenth) edition is dated August, 1905. The frequent revisions seem to have kept the book remarkably up to date, and that without marring its orderly arrangement and good style—a statement that cannot always be made of a frequently revised book.

The authors take up, in succession, air, meteorology, water, food, soil, buildings, schools, hospitals, removal of refuse, disposal of the dead, animal parasites, infection, disinfection, various diseases and their prevention, medical officers of health and sanitary inspectors, sanitary law, factories and workshops, by-laws and regulations, and vital statistics. A number of statistical appendixes close the volume.

After a careful reading of the book the reviewer has but a few specific adverse criticisms to offer. The authors, while setting forth in one place the mosquito theory of malaria, which has been established since their first edition appeared, do not seem to have fully eliminated, in another place, the old telluric (proceeding from the earth) theory. In the section on sewage treatment, to criticise further, there are a few misleading sentences. The uninformed reader would suppose, from the article on chemical precipitation, that chlorides might be removed or reduced by some other process, and also that there would be an advantage in so doing, whereas neither is true, or, if true to any degree, of no practical significance. In another place "two examples" of bacterial processes are cited: the septic tank (anaerobic) at Exeter and the "multiple contact beds" (aerobic) at Davyhulme, Manchester; whereas double contact beds as well as septic tanks are employed at Exeter, and septic tanks as well as contact beds (thus for single contact only) at Manchester. These are relatively unimportant matters, but if touched upon in the book it is due readers that they be right. It may be said, further, that after outlining various proprietary or semi-proprietary processes of sewage treatment, the authors fail to give any clear idea of the relative value of each.

Sommerville's "Practical Sanitary Science," as is stated in its sub-title, is really a handbook for public health laboratories, and, like the book just noticed, it is an American edition of a British work. Collaboration with an American author would have added to the value of the book on both sides of the water, but, of course, more particularly on this side

As might be expected, Sommerville deals chiefly with the analytical methods of the laboratory, and, aside from the bacteriology of water and milk, he concerns himself almost wholly with chemical, physical and microscopical examinations.

About a hundred pages, or a third of the volume, are devoted to water, the factors governing its character, and its analysis. Short chapters deal with the analysis of sewage effluents and of soils, and are followed by a longer chapter on air analysis. Next are taken up milk, butter, meat, cheese, disinfectants, cereals, alcohol and preserved foods. In each case the author makes clear the object of the laboratory examination before describing its methods. An appendix of about fifty pages includes a variety of notes on standard solutions and on the "General Chemical Reactions of the More Commonly Occurring Metals and Acids."

The treatment of turbidity and color determinations, and particularly of turbidity, takes little account of recent refinements tending to eliminate the personal element. The author thinks isochlors, or normal chlorine lines, useless in a country so near the sea at all points as is England, but gives no specific evidence to show that any one has ever attempted to prepare a normal chlorine map for Great Britain, or that the necessary figures could be brought together short of great labor.

The author's sane general discussion of disinfectants deserves a wide hearing and action accordingly. He urges the necessity of testing the bactericidal powers of disinfectants, instead of relying wholly, when any tests are made, upon percentages of the active chemical agents which disinfectants contain. He says some sharp things about trade disinfectants, most of which really have little to boast of except their fancy names. We may add that these worthless proprietary articles are much more abundant in England than in America.

The new edition of Dr. Currier's "Practical Hygiene" contains a large amount of valuable matter, but is stronger on personal than on public hygiene. It is notably weak and behind the times in some of the sections dealing with engineering subjects. The remarks on wood pavements and on large water purification plants serve as illustrations of this. Of sewers the author says that those over 15 ins. in diameter are built of brick and that smaller ones are of salt-glazed pipe, *laid in* concrete. He repeats some of the foolish talk about the enormous waste due to sewage disposal by dilution. Frankfort and Wiesbaden, Germany, are cited as good examples of the chemical precipitation of sewage, whereas the process is no longer used at Wiesbaden, and has been greatly modified of late at Frankfort. Septic tanks, contact beds and percolating filters are not even mentioned, and this in a book revised in 1905!

The chapter on Garbage Disposal is as inadequate and out-of-date as any in the book. It speaks of garbage furnaces as in use in England for the "last 17 years," which was true when the first edition appeared, in 1893. It was likewise true that chimneys 175 ft. high and "fume consumers" (not so named by the author, however) were considered a necessity in England a dozen years ago, but both have been rendered quite unnecessary by improved furnace design and by forced draft, with the high resulting temperatures. None of the recent furnaces are provided with fume cremators, and wherever, in England, very tall chimnies are built at the present day it is generally to satisfy prejudices only. In America tall chimnies may be advisable until we learn more than we yet have from British practice. The author does not mention garbage reduction plants.

Recent improvements in the sanitary protection of the milk supplies of a few American cities, and the great importance of the general adoption of these safeguards, might well have been brought out more clearly. Both milk and the gathering together of children in public and private schools should have been indicated as means of spreading diphtheria and scarlet fever. Diphtheria, the author states, appears to have increased in amount and severity in the last 40 years, which statement, combined with the seemingly inadequate remarks regarding diphtheria antitoxin, lead one to think that much-needed revision was overlooked here also.

The difficulty of isolating the typhoid [illegible]us from a public water supply might [illegible] have been made clearer, and it should [illegible] been stated that the urine of a typhoid pati[illegible] an active agent in the spread of typhoid f[illegible]

Barring such faults of imperfect re[illegible] as have been indicated, Dr. Currier's book, [illegible]dering its size and price, is still a good s[illegible] of the field of hygiene, particularly on its m[illegible]r-sonal side. When the book first appeare[illegible] had few American competitors, and most o[illegible]se were hopelessly behind it. The British [illegible]s, good as they were, did not so well meet Ameri[illegible]can needs as they do to-day. In the last [illegible]teen years books on hygiene and sanitation ha[illegible] increased notably, in number and in qua[illegible] at home and in England. All the more need, therefore, for either thoroughly revising the old books or letting them die a natural death.

The foregoing criticisms have been ma[illegible] with regret, particularly in view of the fact that Dr. Currier was for some years one of the few American physicians who was at all posted on the engineering side of sanitation. His interest in the subject (or at least we suppose that to have been the reason) was so deep that he joined the American Society of Civil Engineers and took part in discussions before that society. But, judging from the present edition of his book, his interest in sanitation must have flagged of late, or his professional duties have kept him from following its recent progress; or else he or the publishers have been derelict in the matter of revision. Both general causes may have contributed to the defects which we have noted, since they are not wholly confined to the engineering problems discussed. It really seems a pity not to keep so generally excellent a book abreast with the times, particularly in view of the announcement in the preface, to the effect that the book is widely used in educational institutions.

TRAUTWINE'S
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Scientific Publishers
43 and 45 East Nineteenth Street
NEW YORK CITY

Lea's Hydrographic Surveying.

Reviewed by E. C. Murphy.*

HYDROGRAPHIC SURVEYING.—Methods, Tables and Forms of Notes. By Samuel Hill Lea, M. Am. Soc. C. E. New York: The Engineering News Publishing Co. Cloth; 6 × 9¼ ins.; pp. 172; 99 figures, mostly in the text. $2 net.

The author states in the preface to this manual that its purpose is to explain such features of hydrographic surveying as are likely to be encountered in actual practice. Much of the information was acquired in the course of his professional work. The greater part of the matter presented is declared to be elementary, and the formulas used are stated in their simplest form. A large part of the fieldwork of a hydrographic survey is identical with that of a topographic survey; therefore the space is mainly given to the details not so well known, but necessary to the proper execution of hydrographic work.

The manual is divided into two parts: (I.) Four chapters dealing with operations not involving measurement of stream flow; (II.) two chapters treating chiefly of measurement of stream flow. In Part I. the author first treats of methods of determining the outline of bodies of water and drainage areas, the survey of reservoir sites, and computation of capacity. In connection with each method, the make-up of the party, its outfit, form of note-book and the office work are considered. He next describes in considerable detail methods of making and locating soundings and sounding machines; then he treats of the note-keeping and office work, of sounding and the preparation of hydrographic maps and charts. Part I. closes with a discussion of the measurement of material to be dredged, both in place and in scow, and the measurement of the volume of a lake. The last-named subject matter is closely related to that forming the opening chapter of the book.

The first chapter of Part II. treats of some of the instruments and methods in use for the measurement of stream velocity. The Fteley and Price current meters, especially the latter, are described and illustrated in detail. The terms "acoustic" and "electric" are wrongly applied to the Price meter. It is the Price electric meter that is "extensively used" by the Division of Hydrography of the U. S. Geological Survey, and shown in the author's Fig. 68. The detailed description of how best to operate the non-electric Fteley meter with the aid of an assistant seems unnecessary when the Fteley electric can be operated by one person more rapidly than the non-electric. Exception may be taken to the statement on page 120, that the thread of mean velocity in a shallow stream is at 0.6 of the depth below the surface.

The author next treats of methods of fieldwork and computation of discharge; the measurement of discharge by weirs and by surface, slope and cross-section. Curves of velocity in vertical and horizontal planes of a stream; measurements of flow under ice and sediment observations are briefly treated. The statement on page 124 that a discharge station should be at a "typical section" of the stream is questionable. In mentioning the meter rating stations of the U. S. Geological Survey the author omitted the station at Denver, Colorado. The fact that dams may be used as measuring weirs under certain conditions is mentioned, but there are no data given or references made to data from which the proper discharge coefficient for any type may be obtained. References to works that treat parts of the subject more in detail than does this book, and to tables and diagrams that lessen the labor of computation, would add to the value of the manual.

The student or surveyor desiring to get a practical knowledge of hydrographic surveying in a short time will find that this manual will meet his need. The engineer who has Johnson's Surveying, or some recent comprehensive book on surveying and a copy of the Hydrographic Manual of the U. S. Geological Survey, will have little need for this work.

*Engineer, U. S. Geological Survey, Washington, D. C.

Just Published

PRACTICAL CEMENT TESTING

By W. PURVES TAYLOR

This book is now ready; but before it was off the press it had been adopted as a text-book by the University of Pennsylvania. While a good deal has been published in the columns of journals and magazines on the subject of cement testing, it has remained for Mr. Taylor to present in book form the first practical and exhaustive treatise on the subject. That he is eminently fitted as an author of a practical book is evident from the fact that he has been, for years, the engineer in charge of the Philadelphia Municipal Testing Laboratories, and during that time has written many original and valuable articles on the testing of cement. The book is so complete that it can be put into the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. Hitherto it has been necessary to instruct all young testing engineers by word of mouth and by example. This book has a wealth of photographs and line cuts—150 in all—that furnish the pictorial examples of how to conduct cement tests; and the 300 pages of text are so explicit that even the most inexperienced man can soon learn the art of cement testing. It is an art, and by no means so simple as some may imagine. Indeed, it will surprise many to know that a 300-page book can be written upon this subject. Yet the book has not a superfluous paragraph. The list of chapters is as follows: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13), Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement Than Portland, (16) Specifications, (The Author's, Am. Soc. C. E., Am. Soc. Test. Mtls., Soc. Chem. Indust., Corps Eng. U. S. A., British Standard, Can. Soc. C. E.)

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THE MYRON C. CLARK PUBLISHING CO., 13-21 Park Row, New York

Shaw's Machine Tools Continued.

Reviewed by William W. Bird.*

MACHINE TOOLS.—For Planing, Shaping, Slotting, Drilling, Boring, Milling, Wheel Cutting, etc. Their Design and Construction. A Companion Work to "Lathes, Screw Machines, Boring and Turning Mills." By Thomas R. Shaw, A. M. I. Mech. E. Manchester, Eng.: The Scientific Publishing Co. Cloth; 5½ × 8¾ ins.; pp. 676; 467 figures, mostly in the text. 15s., net; American price, $6.

Machine tools have been divided by the author into two classes: (1) machines designed to give direct rotary motion; (2) those designed to finish work either held stationary or moving in straight lines. The first group has been fully described by Mr. Shaw in his "Lathes, Screw Machines, Boring and Turning Mills." The present and companion volume takes up the second group.

The author has collected and here presents a very complete description of all the prevailing types of machines which naturally come in this second group. The description in most cases includes construction as well as operation, and in some cases many of the details are given. The author has drawn upon the proceedings of the various engineering societies of England and America for his data and descriptive matter, and also upon the prominent manufacturing concerns of all countries for drawings and cuts.

The book is divided into nine chapters and an appendix. The general titles and distribution of space are as follows: Planing Machines, 111 pages; Shaping and Slotting Machines, 56; Vertical Drilling, 56; Radial Drilling, 51; Horizontal Drilling and Boring and Multispindle Drilling, 70; Milling, 100; Wheel Cutting, 53. The final chapter and the appendix are headed Items of Interest and Miscellaneous Matter, respectively.

Each chapter has a number of valuable suggestions, illustrations, tables and data, with hints on methods of designing parts. This naturally makes the book of more value to the designer, draftsman and student than to the workman. The latter, however, will find the book well worth reading, and the others will find enough of value to make the book worth owning.

The book is well illustrated throughout and the description of the various machines is clear and concise. While nothing novel, startling or unique develops in the book, it reaches the aim of the author, and in the estimation of the reviewer is the best assemblage of descriptive data of the machine tools included that has so far been published. It is to be hoped that the author will be able to continue his good work in future editions and keep up with the rapid progress which is now being made in machine tool design.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Proceedings of the Eighth Annual Meeting, Atlantic City, N. J., June 29, 30, July 1, 1905. Vol V. Philadelphia, Pa.: The Society (Prof. Edgar Marburg, Secretary, University of Pennsylvania). Paper; 6 × 9 ins.; pp. 565; 10 plates and many text illustrations.

AMERICAN WATER-WORKS ASSOCIATION.—Proceedings of the 25th Annual Convention, held at West Baden, Ind., May, 1905. (John M. Diven, Secretary, Charleston, S. C.) Cloth; 6 × 9¼ ins.; pp. 444; folding plates and many illustrations in the text.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.—Proceedings of the Thirty-third Annual Convention, Duluth, Minn., Aug. 16-19, 1905. (James McFall, Roanoke, Va., Secretary.) Paper; 5¾ × 9 ins.; pp. 235; illustrated.

The proceedings of each of the first two of these societies were reported, and some of the papers were printed, in Engineering News directly after the dates of the meetings, as given above. Each of the volumes here listed contains a large amount of information of direct appeal to a large and growing class of engineers and specialists. In the way of specifications alone the volume issued by the Society for Testing Materials includes standard specifications for steel bridges, steel castings, steel axles and steel forgings, besides committee reports on either standard specifications or tests for cast iron, car wheels, gray iron castings, cement, preservative coatings for iron and steel, road materials, reinforced concrete, staybolts, lubricants, fire-proofing materials and structural timber. In addition, numerous papers are given.

*Professor of Mechanical Engineering and Director of the Washburn Shops, Worcester Polytechnic Institute, Worcester, Mass.

The report of the Water-Works Association contains papers and discussions on dams, pumping engines, steam turbines, filtration, gate chamber screens, water rates, books for the water-works office and other subjects.

Topical discussions rather than papers seem to be the rule at the meetings of the International Association of Fire Engineers. Some of the topics in 1905 were fire protection for excursion and passenger steamboats, spray nozzles, searchlights, advantages of automobiles over horses for fire service, standard threads for hose and hydrants, and stand-pipes.

WATER SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.

Nos. 137, 138 and 139: Development of Underground Waters in the Eastern, Central (No. 138) and Western (No. 139) Coastal (137) Plain Region of Southern California. By Walter C. Mendenhall. Pp. 140, 162, 105; plates (including maps in pockets) and text figures.

No. 142: The Hydrology of San Bernardino Valley, California. By Walter C. Mendenhall. Pp. 124; 12 plates (three in pocket) and 16 text figures.

No. 147: Destructive Floods in the United States in 1904. By Edward Charles Murphy and others. Pp. 206; 18 plates and 19 text illustrations.

No. 151: Field Assay of Water. By Marshall O. Leighton. Pp. 77; four plates and three text figures.

In utility and timeliness the four papers by Mr. Mendenhall will rank high in this series. The first three give, by means of brief text and extended tables, a large amount of information regarding the wells as a whole and also individual wells in Los Angeles and Orange Counties; the fourth paper in the list is a broader treatment of both the surface and underground waters of the San Bernardino valley.

These two districts comprise a large percentage of the most highly developed portion of Southern California, the very life of which is dependent in a peculiar and unusual degree upon its water supply, and particularly upon underground water. In recent years there has been a marked falling off in the yield of the wells of this region, accompanied, of course, by a fall in the water level. Pumping is therefore becoming more and common.

Mr. Mendenhall's tables and maps contain a vast amount of information regarding the wells in Los Angeles and Orange Counties, based largely on visits to the wells. He also presents some instructive diagrams, showing how the rainfall has fallen below the average of late, and some conclusions based on a review of all his data.

The collection and study of information regarding destructive floods, now well begun by the U. S. Geological Survey, promises to be of great value to engineers. In Paper 147, by Mr. Murphy and others, records of floods distributed over a large part of the United States are presented. Mr. Murphy also contributes a paper on "Drought in the Ohio River Drainage Basin," and another on "A Method of Computing Cross-Section Area of Waterways."

Mr. Leighton has added another (No. 151) to his creditable list of papers on the sanitary and economic aspects of water supply. As the title implies, the paper deals with methods of water examination that can be made in the field by means of an equipment carried on horseback or by hand. The object of these field assays is not extreme accuracy, but rather approximate results to serve as general indications of the character of water of a given source, chiefly for comparative purposes; that is, for comparison of water from the same source over a period of years and also with waters from other sources. The determinations described include turbidity, by Jackson's turbidimeter; color, by means of colored glass disks rated by the Hazen cobalt-platinum standard; iron, also by color disks; chlorides, hardness, and sulphates, by means of silver nitrate, sodium oleate and sodium acid sulphate tablets, respectively; and sulphates, by means of the turbidimeter. Tablets of known strength are used with such other agents as may be necessary to produce a certain reaction or color in the water to be tested. Further information regarding these various tests and the results obtained by them may be found in an article by Mr. Leighton on "The Field Assay of Water," published in Engineering News for June 8, 1905.

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THE USE AND CARE OF CHAINS FOR LIFTING AND HAULING.—A Paper read before the Civil & Mechanical Engineers' Society on the 27th April, 1887. By Henry Adams, M. Inst. C. E., M. Inst. Mech. E., Professor of Engineering at the City of London College. Second Edition. London: 60 Queen Victoria St. Paper; 5½ × 8½ ins.; pp. 20; 13 figures on one plate. 1s.; American price, 40 cts.

A second edition of this reprinted paper, 18 years after its first appearance, is in itself an indication of its value. The paper in full may also be found in Engineering News for Aug. 6, 1887, and "The Engineer" (London) for July 8, 1887. This is the only paper on the subject recorded in several issues of the Engineering Index, covering the years 1884 to 1900, inclusive, and we do not know of any of later date. A paper on "The Wear of Chains," by R. Weatherburn, appeared in "The Engineer" for July 8, 1898.

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A Quartet of Year Books.

BETON-KALENDAR, 1906.—Pocketbook for Concrete and Reinforced Concrete Construction, and Related Branches. Published by "Beton und Eisen," with the cooperation of prominent experts. First issue. Berlin, Germany: Wilhelm Ernst & Son. Cloth: 4 × 6½ ins.; pp. 206 + 72; over 650 figures in the text. 3 marks; American price, $1.20.

FOWLER'S ELECTRICAL ENGINEER'S YEAR BOOK AND DIRECTORY OF LIGHT, POWER AND TRACTION STATIONS, 1906.—Manchester, Eng.: Scientific Publishing Co. Leatherette; 4 × 6¼ ins.; pp. 643; illustrated. Post free, 1¾ shillings; American price, 70 cts.

FOWLER'S MECHANICAL ENGINEER'S POCKET-BOOK, 1906.—Edited by William H. Fowler, Wh. Sc., M. Inst. C. E., M. I. Mech. E., M. Iron and Steel Inst. Manchester, Eng.: Scientific Publishing Co. Leather or leatherette; 4 × 6¼ ins; pp. 516; illustrated. Post free, 1/9; American price, 70 cts.

THE "MECHANICAL WORLD" POCKET DIARY AND YEAR BOOK FOR 1906.—Containing a Collection of Useful Engineering Notes, Rules, Tables and Data. Manchester, Eng.: Emmott & Co., Ltd. Cloth; 4 × 6¼ ins.; pp. 390; 73 figures in the text, and many tables. 6d. net; American price, 20 cts.

These four books have this characteristic in common: that they are not year-books at all, or only in infinitesimal degree. Two of them make a claim to the title by giving a series of almanac or diary sheets, and one of the other two gives a list of data of electric stations in "London and the Provinces," including name of owner and engineer," and character of generating and distributing equipment, presumably corrected to date. With these exceptions, all four books are pocket companions or handbooks, giving more or less condensed information on theory and practice in the various branches of their several fields, but contain nothing that might be considered peculiar to the year 1905 or 1906.

Von Emperger's "Beton-Kalender" represents an attempt to cover the large field of concrete construction by a treatise of pocket size. The contents exhibit unequal parts of analytical, descriptive and didactic matter; that is to say, there is some theory, much description, and a certain amount of practical guidance for both design and construction. About two-thirds of the work deals with concrete and immediately related matters; the rest, occupying the first part of the book, is made up of logarithm tables, short sections on surveying, strength of materials, etc. The portion concerned with concrete is made up of chapters written each by a separate person and dealing with a separate theme: concrete-mixers, bridges, dams. The result is a great lack of unity and absence of clear or effective arrangement. Duplication of matter is also produced to some extent. Of these separate chapters, some are excellent summaries of their subjects, considered with regard to the limitations of space, while other chapters have but little value, and still others have no connection whatever with the theme of the book. Examples of the latter are the chapter on city sanitation, the larger part of the chapter on city drainage, and in part also the chapter on river regulation.

On the whole, the book forms a handy collection of examples of reinforced concrete construction; not a complete, but still a useful collection. Its serious fault is in the editorial handling, already criticized in our remark on the lack of unity of the contents. Concerning reinforced-concrete stairs, the statement is made (p. 118):

> One of the great advantages of reinforced concrete stairs is the fact that they can be built without massive staircases (supporting structure?) by using either the cantilever principle or by extension of the neighboring floor-beams.

Similarly, in the description of a theater of reinforced concrete, where the balcony overhangs its supporting columns by 18 ft., this remark occurs (p. 196):

> Specially to be noted is the length of overhang, 5.6 m., which is rendered possible by the use of reinforced concrete.

Such statements are injurious to reinforced concrete in the degree that they are incorrect and meaningless. They are to be charged to careless editing, as is also the quoting of "Central Speck Co" (p. 200) for "Central Lard Co."

If the "Beton-Kalender" is to be issued fresh every year in the future, we trust that its disturbing faults, some of which have been briefly indicated, may be corrected. It will be proper, also, to give it a continuous paging instead of making three separate starts. The book gives promise of becoming a very useful and valuable handbook.

Fowler's "Electrical Engineer's Year Book" is a condensed compendium of electrical formulas, descriptions of instruments and methods of testing, properties of electric machines, and practice in arranging electric plant. English governmental regulations and similar standard rules are liberally quoted. About fifty pages on steam and mechanical plant are given toward the close, which space could have been more profitably applied to amplifying the electrical text, as by showing trolley and trolley-line constructions, amplifying the fifteen lines devoted to conduit traction systems, describing circuit-breakers, etc. For its very low price the book is a very satisfactory and compact electrical handbook.

The "Mechanical Engineer's Pocket Book" of the same author can be described by remarks similar to the above, translated from electrical into mechanical language. Its contents are all such as will be of value to the user of the book, but its omissions will be felt. Chief of the latter is the omission of anything on machine design, on gears, or on machine tools (except the lathe), or on tools in general (with unimportant exceptions).

The omissions of the last-named work are in part supplied—and well supplied—in the "Mechanical World Pocket Diary and Year Book." This book, however, is equally silent on tools and machine tools. Considered by itself, it is fragmentary in at least the same degree as the other, if not more so. The two together are about twice as satisfactory as one alone. The "Mechanical World Pocket Diary" is notably the better of the two in paper and printing.

CAMS AND THE PRINCIPLES OF THEIR CONSTRUCTION.—By George Jepson, Instructor in Mechanical Drawing in the Massachusetts Normal Art School; Master of Columbus Avenue Evening Drawing School, City of Boston; Medallist Science and Art Department (Great Britain). New York: D. Van Nostrand Co. Cloth; 6 × 9½ ins.; pp. 59; 37 figures, partly in the text. $1.50, net.

This brief treatise, while covering the general principles of cam design and construction, shows only the more common forms, such as the frog, face, cylinder, involute and yoke cams. Beginning with first principles, each step in the construction of the simpler cam motions is described and illustrated. The author devotes considerable space to the development of the ogee or harmonic curve, as used on the frog or face cam. Particular attention is paid to the design of the cam leader and its roller, the adjustable attachment applied to a milling machine for cutting cams. Two forms, the open and the closed, are described, and pictorial illustrations are given of milling machines equipped with each. The latter part of the book is devoted to "writing cams," and gives the complete method of procedure to be followed in construction.

WAGES AND HOURS OF LABOR.—Nineteenth Annual Report of the Commissioner of Labor, 1904. Washington, D. C.: Pub. Doc. Cloth; 6 × 9¼ ins.; pp. 976; mostly tables.

This huge volume of statistics covers the period 1890 to 1903 by means of eight tables. Of these the first five deal with both wages and hours of labor, thus: (1) By occupations; (2) industries; (3) occupations and geographical divisions; (4) by 21 selected occupations, in cities; (5) by 18 selected occupations, by States. Tables 6 and 7 deal with classified wages in selected occupations, 21 by cities and 18 by states. Table 8 shows the percentage of establishments working each specified number of hours per day, by industries and geographical divisions. The 14 pages of text describe and explain the tables and give some of the deductions that may be drawn from them.

Bulletin No. 59 (July, 1905) of the U. S Department of Commerce and Labor also contains extensive tables on "Wages and Hours of Labor, 1890-1904," and on "Retail Prices of Food" for the same period. Some comments on the annual report and a diagram from the bulletin were published in the editorial columns of Engineering News for Sept. 28, 1905.

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GAS AND OIL POWER.—The Illustrated Monthly Review for Factory Owners and Other Power Users. Vol. I., No. 1. Oct. 15, 1905. 19 Ludgate Hill, London, England. Paper; 8½ x 11 ins.; pp. 28. 6d.

Among English engineering periodicals there are at present none which cover the distinct field outlined by "Gas and Oil Power" in this its first issue. While the subject matter will deal more particularly with the methods of obtaining power from gas and oil, which are the most economical sources, some space will be devoted to the means of transmitting the power so obtained.

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Literary Magazines.

Two articles of particular interest to engineers are found in the January "Century." Mr. Oscar King Davis describes "The Lucin Cut-Off," the new line of the Southern Pacific Ry. across Great Salt Lake. The work was described in this journal at the time of its construction, but Mr. Davis' article gives more particulars than have hitherto been available concerning the very serious difficulties encountered in this work, particularly in the continual sinking of sections of the great embankment into the mud at the bottom of the lake. On March 24, 1903, the first locomotive was started across the cut-off; but for a year and nine months thereafter the embankment continued to settle as fast as new material was piled upon it. Not till a year afterward did freight traffic begin to run over the new line, and it was not till Sept. 18, 1904, that it was deemed safe to divert passenger trains to the new route. The description of the work is an excellent one, but, while it is referred to as a great and successful engineering feat, no figures are given to enable one to judge whether its construction was really a wise measure. It is stated, indeed, that for January, 1905, the operating expenses of the new road were $61,000 less than the operating expenses of the old line in January of the previous year; but there are no figures given for the cost of the new line, and without them it is not clear that a modified diversion skirting the north shore of the lake from Promontory point westward would not have given a line nearly as good at less expense for construction, and particularly for maintenance. The Lucin line includes no less than 12 miles of permanent trestle-work, and the maintenance of this in water of the varying level of that in Great Salt Lake is likely, one would suppose, to be a heavy item.

In "The Century" also Mr. Samuel Spencer, President of the Southern Railway, writes on Railway Rates and Government Control," and makes an argument to the effect that railways must be able to so adjust their rates as to give every shipper a chance, and that the tendency of Government controlled rates will be to prevent the railways from making concessions to enable new business to be developed and unusual exigencies to be promptly met. A point not touched upon, however, is that when railways have the power thus to reduces rates in accordance with what the traffic will bear, they have likewise the power to advance them also to what the traffic will bear.

In the "World's Work" for January we find an account of the construction of the San Pedro, Los Angeles & Salt Lake R. R., 778 miles long, from Salt Lake City southwest through Southern Nevada to the Pacific coast. In the same magazine we find a paper by C. M. Keys, Assistant Editor of the "Wall Street Journal," entitled "How Men Get Rich Now," containing the following curious story:

> How have honest fortunes been acquired? And how may honest fortunes now be got? Most fortunes come from a happy union of the right man and the opportunity. About the beginning of the '90's, a junior officer of the Pennsylvania Roailroad went to Europe on a holiday. He had a good position, a little capital and some good friends. He went sightseeing with his eyes wide open. That was his habit. Wales fascinated him. Wales was the country that supplied the world with tin. He knew that the huge tin deposits of his state, Indiana, had lain idle because the tin of Wales held the world's markets, including Indiana. The people of the state, whose houses were built over tin deposits, paid to Welsh manufacturers every year many thousands of dollars for tin. The markets of the United States had lain wide open to the tin of Wales. The change in tariff, at about the time of his visit, had put a duty on this imported tin.
>
> Back in his native state he talked tin, thought tin, dreamed of tin. Here was his opportunity. Most of all he talked to a boyhood friend who, by hard work and genius, had come to be the vice-president of a small country bank in Indiana.
>
> "Under our feet," he said, "lie millions. We allow Welshmen to keep them buried. This is our chance. Suppose we start a tin mill of our own. They can't pay this new duty and beat us here in Indiana. The local trade will make us rich."
>
> Probably he said the same thing over many times. The upshot of it was that he and his friend gathered together a small group of helpers and built the first tin plate mill of any importance in the state. Within seven years that mill had come to be the head and center of the Tin Plate Trust. The man with the idea was Mr. W. B. Leeds. The bank vice-president was Mr. Daniel G. Reid. To-day these men are directors of railroad companies owning more than 15,000 miles of road.

We need hardly say that the "huge tin deposits of Indiana" exist only in the lively imagination of Mr. Keys; and, while Wales has long been famous for its tin plate, it is not Wales, but Cornwall, that supplies metallic tin. In other words, it is clear that the intelligent writer who tells us "how men get rich now" does not know the difference between tin and tin plate. Possibly such ignorance may be excusable in a financial writer or in the editorial staff of a magazine which is supposed to give information on "The World's Work"; but isn't it asking a little too much of the credulous reader to refer to "honest fortunes" in connection with the financial jugglery which created the tin plate trust and the Rock Island railroad transformations?

ANNUAL REPORT OF IRRIGATION AND DRAINAGE INVESTIGATIONS, 1904.—Under the Direction of Elwood Mead, Chief. Bulletin No. 158, Office of Experiment Stations, U. S. Dept. of Agriculture. A. C. True, Director. Washington, D. C.: Pub. Doc. Cloth; 5¾ × 9¼ ins.; pp. 755; 12 plates and 129 text illustrations.

The irrigation studies begun a few years ago under the direction of Mr. Mead, an engineer experienced in irrigation work, are now being systematically carried out along several important and many minor lines. From the first attention has been directed to such obvious topics as the duty of water and the best means of applying water to the land. To both of these ends specific canals and irrigated lands have been studied in detail. Several such studies are reported in this volume. More recently pumps and cost of pumping water for irrigation have been taken up. In the present volume there is a section of some sixty pages on tests of pumping plants, written by Prof. J. N. Le Conte, of the University of California, and also papers on pumping plants in Texas, by C. E. Tait, and in Colorado, Nebraska and Kansas, by Prof. O. V. P. Stout, of the University of Nebraska. The final hundred pages of the volume are on drainage, by C. G. Elliott, Engineer in charge of drainage investigations.

THE PRODUCTION OF PRECIOUS STONES IN 1904.—By George F. Kunz. Extract from Mineral Resources of the United States, Calendar Year 1904: David T. Day, Chief of Division of Mining and Mineral Resources. Washington, D. C.: Pub. Doc. Paper; 5¼ × 9 ins.; pp. 120.

As might be expected, subject and author considered, this report contains much interesting matter. Perhaps most fascinating of all its contents is the section on diamonds, in which the author describes a number of the most famous diamonds of the world, diamond cutting processes, the use of diamonds in the industrial arts, and reviews the year's output of diamonds from the leading mines of the world. The largest diamond known was discovered in January, 1905, in the Premier Mine, Transvaal, South Africa. It weighs 3,024¾ carats, or 1.37 lbs. avoirdupois, measures 4 × 2½ × 1½ ins., and has a theoretical value of $45,000,000. Several pages of the report are devoted to this remarkable diamond.

INDUSTRIAL OPPORTUNITIES NOT YET UTILIZED IN MASSACHUSETTS.—Part IV. of the Annual Report for 1905, Massachusetts Bureau of Statistics of Labor. Chas. F. Pidgin, Chief. Boston, Mass.: Pub. Doc. Paper; 5¾ × 9¼ ins.; pp. 151 to 301.

There is embodied in this report the results of an inquiry addressed to the selectmen of the various towns of Massachusetts. Returns were received from 231 towns, or 72% of the total number in the State, giving more or less information regarding land, water-power, natural products, available labor and railroad facilities suitable for manufacturing purposes. Included with the returns are given populations, distances and railway fares from Boston, and other useful data. The returns also cover brief statements regarding water supply, lighting and street railway facilities. Following the reports by towns are tabular summaries.

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BENEVOLENT INSTITUTIONS—1904. Special Reports, Bureau of the Census. S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.; pp. 335.

GASWORKS ACCOUNTS AND MANAGEMENT.—By George Helps. London, Eng.: The "Gas World" Offices. Cloth; 4¾ × 7½ ins.; pp. 151; two folding plates. 5s.; American price, $2.

GEOLOGIC ATLAS OF THE UNITED STATES.—U. S. Geological Survey, Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Stiff paper; 18 × 22 ins.

No. 126: Bradshaw Mountains Folio. Arizona. Pp. 11; five plates.

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HYDRAULIQUE AGRICOLE ET URBAINE—By G. Pechmann. Engineer in Chief of Bridges and Roads; Member National Agricultural Society, etc. In Encyclopédie des Travaux Publics. Paris, France: Ch. Béranger. Paper; 6½ × 10 ins.; pp. 642; many illustrations. 20 francs; American price, $6.

THE MENACE OF PRIVILEGE.—A Study of the Dangers to the Republic from the Existence of a Favored Class. By Henry George, Jr. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5¼ × 8¼ ins.; pp. 421. $1.50, net.

MINERAL PRODUCTS OF THE UNITED STATES.—Calendar Years, 1895 to 1904. David T. Day, Chief of Division of Mining and Mineral Resources, U. S. Geological Survey. Washington, D. C.: Pub. Doc. Large sheet, containing tables.

MODERN MACHINE SHOP CONSTRUCTION, EQUIPMENT AND MANAGEMENT.—By Oscar E. Perrigo, M. Am. Soc. M. E., Expert in Machine Shop and Factory Organization, Modern Shop Methods, Time and Cost Systems, etc. New York: The Norman W. Henley Publishing Co. Cloth; 7½ × 10½ ins.; pp. 343; 208 figures in the text. $5.

ONTARIO COMMISSION ON RAILWAY TAXATION.—Report for 1905. (H. J. Pettypiece, Chairman, Toronto.) Toronto, Ont.: Pub. Doc. Paper; 6½ × 9¾ ins.; pp. 219.

THE NATURE OF ORE DEPOSITS.—By Dr. Richard Beck, Professor of Geology and Economic Geology, Freiberg Mining Academy. Translated and Revised by Walter Harvey Weed, E. M.; M. Inst. Min. Eng. (England); M. Am. Inst. M. E.; Geologist, U. S. Geological Survey. In two volumes. New York and London: The Engineering and Mining Journal. Cloth; 6¼ × 9½ ins.; pp. 685; 272 figures in the text, and one folding map. $8.

PRACTICAL PATTERN-MAKING.—By F. W. Barrows. New York: The Norman W. Henley Publishing Co. Cloth; 5 × 7½ ins.; pp. 326; 141 figures in the text. $2.

REVISED NOMENCLATURE OF THE OHIO GEOLOGICAL FORMATIONS.—By Charles S. Prosser, M. Sc.; Professor of Geology, Ohio State University. Fourth Series, Bulletin No. 7, Geological Survey of Ohio. Edward Orton, Jr., State Geologist. Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. xv. + 36.

STATISTICS OF MANUFACTURES.—1903, 1904. Part V. of the Annual Report for 1905, Massachusetts Bureau of Statistics of Labor. Chas. F. Pidgin, Chief. Boston, Mass.: Pub. Doc. Paper; 6 × 9¼ ins.; pp. 308 to 373.